Electrical Review

WITH WHICH IS CONSOLIDATED WESTERN ELECTRICIAN AND ELECTROCRAFT.

VOL. 72—No. 17. CHICAGO, SATURDAY, APRIL 27, 1918. PAGE 707.

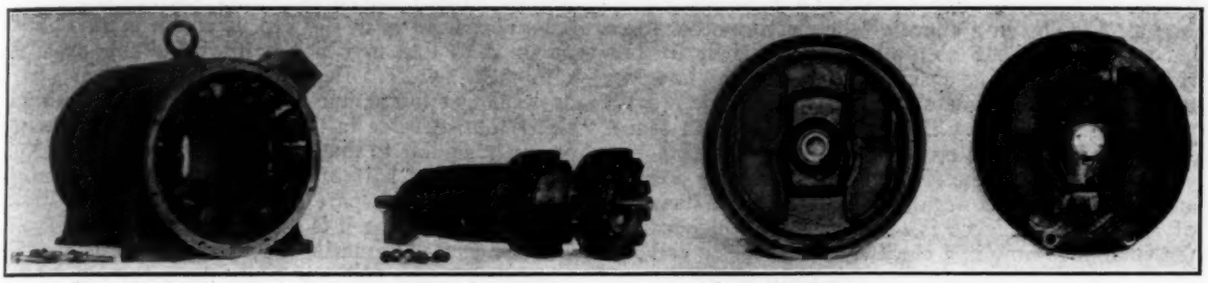


Fig. 1.—Parts of a ½-Kilowatt Inductor Type Generator.

Characteristics of the Inductor Type Generator

Principle of Operation, Testing and Predetermination of Operating Characteristics of Inductor Type Machines Such as Are Now Commonly Used in Wireless Work

By MILLARD C. SPENCER

THE INDUCTOR type generator has come to be almost universally recognized as the standard type of generator for the 500-cycle, single-phase power supply of the modern wireless telegraph station, the reason being that this type of machine possesses a number of very real advantages which are not common to the usual type of generator. Chief of these advantages is the fact that all the windings in this type of machine are stationary and therefore no commutator, slip rings, or any other form of moving contact is required. This tends to make the inductor type generator an exceedingly reliable machine and one which requires a minimum amount of attention while in operation.

It is with machines of this type, an illustration of which is shown in Fig. 1, that this article has to deal.

Principle of Operation.

As the inductor type generator operates on a somewhat different principle from that of the usual type of alternating-current generator, the following description of its method of operation is given in some detail.

In Fig. 2(a) is shown in a diagrammatic way a longitudinal section through the center of a machine of this type. The field coil, which is in the form of an annular ring, is located in the center of the machine. The field flux set up by this coil passes through the stationary frame in an axial direction, down through the stator core on one side of the machine, across the air gap and into the rotor poles, through the rotor in an axial direction, up through the rotor poles on the other side of the machine, across the second air gap, through the second stator core, and back into the frame.

Fig. 2(b) shows a vertical section through one end of the machine. (A section through the cores at the other end of the machine would be exactly similar.) As shown in this figure, the rotor poles have no windings whatever. They receive their magnetism entirely by induction from the one large stationary field coil. An examination of these two figures will readily show that all the rotor poles on one side of the machine are of the same polarity. For the direction of flux shown in Fig. 2(a) all the rotor poles on the right-hand side of the machine are north poles, while all the poles on the left-hand side of the machine are south poles.

For the particular rotor position shown in Fig. 2, the flux through the armature coils is a maximum; but it is easy to see that when the rotor has moved forward one stator-slot pitch (or one-half a rotor-pole pitch) that the flux through these same coils will be a minimum. This periodic linking of the flux through the stator coils, as the rotor revolves, generates in these coils an alternating electromotive force, or current when the circuit is closed. A better conception of the action of this flux in generating a true alternating current in these armature coils can, perhaps, best be had by viewing this action from the standpoint of the cutting of conductors by lines of flux rather than by the theory of linkages.

In Fig. 3 (a to g) is shown, in a series of sketches, an enlarged view of a small section of Fig. 2(b). One

of the stator coils, the two sides of which lie in slots No. 1 and No. 2, respectively, is indicated in a diagrammatic way as *AB*. It is assumed that the magnetic flux is passing from the rotor into the stator and that the rotor is revolving at a uniform speed in the direction shown by the arrows.

For the instant shown in Fig. 3(a) it is seen that practically no flux is cutting either the conductor (or conductors) *A* in slot No. 1 or *B* in slot No. 2; therefore, the electromotive force generated in coil *AB* is practically zero. This is indicated by point *a* in Fig. 4. In Fig. 4 is shown a curve of the electromotive force generated in coil *AB* as the rotor moves forward one rotor-pole pitch. The abscissas of Fig. 4 may be taken to represent either time or the position of pole *N* with respect to slot No. 1. The ordinates of Fig. 4 represent the instantaneous values of the electromotive force, those above the *X* axis being taken as positive and those below as negative. The positive direction of electromotive force is taken as that which causes the current to flow in a clockwise direction in coil *AB* when looking down upon the coil from above.

As the rotor moves forward to the position shown in Fig. 3(b) it is seen that the flux cutting the conductors in slot No. 1 rapidly increases, which causes the electromotive force generated in these conductors, and therefore in the coil *AB*, to rapidly increase. This is shown by the portion *ab* of the curve in Fig. 4. As the rotor moves from position (b) to position (c), Fig. 3, the flux cutting the conductors in slot No. 1 remains practically constant and therefore the electromotive force of coil *AB* remains practically constant, as shown by *bc* in Fig. 4. As the rotor moves from (c) to (d), the flux cutting these same conductors rapidly diminishes, thus causing the electromotive force to drop from *c* to *d*, Fig. 4. When in the position (d), Fig. 3, practically no flux is cutting either the conductors of slot No. 1 or No. 2 and therefore the electromotive force of coil *AB* is zero, as shown at *d*, Fig. 4.

During the entire time that the rotor was moving from position (a) to position (d) no flux whatever (neglecting leakage) cut the conductors of slot No. 2 and therefore the conductors of this slot remained entirely inactive as far as generating useful electromotive force. From this is seen one of the chief limitations of machines of this type; that is, that only one-half of the armature conductors are active at any one time.

Continuing the study of Fig. 3, it is seen that as the rotor moves into position (e) the flux begins to cut the conductors of slot No. 2. This electromotive force causes current to flow *down* in slot No. 2 which is the *same* direction that a moment before it caused current to flow in the conductors of slot No. 1; but, since the conductors of slot No. 2 form one side of a coil of which the conductors of slot No. 1 form the other, it is evident that if the current flows down in slot No. 2 it must now flow up in slot No. 1, which is the opposite direction to that in which it flowed in this same slot a moment before. In moving from position (d) to position (g) the action of the rotor in generating an electromotive force in the conductors of slot No. 2 is precisely similar to that which took place at slot No. 1 during the first half of the cycle. The electromotive force is shown by part *defg* of the curve of Fig. 4. From the foregoing it is quite evident how a complete cycle of a true alternating electromotive force has been generated in the coil *AB* while the rotor moved forward one rotor-pole pitch, although the direction of the flux has remained constant during the entire period.

The action which takes place at each of the 12 coils shown in Fig. 2(b) is, of course, precisely the same as that which has been described above for the coil *AB*. The same is true of the 12 coils on the stator core at the other end of the machine with the exception that here the flux passes from the stator core into the rotor and therefore the direction of the electromotive force of these coils is opposite to that of the coils on the first side of the machine. However, since these electromotive forces are exactly 180 degrees out of phase, the coils on the two sides of the machine may be connected in series and the voltages caused to add directly by simply reversing the leads from one set.

The formula for the frequency of machines of this type, which follows directly from the above discussion, is frequency = poles × r. p. m. ÷ 60
where frequency = cycles per second, poles = number of rotor poles (or teeth) on each end of the rotor, r. p. m. = revolutions per minute.

Tests.

The usual tests which are made on machines of this type consist of a few comparatively simple and readily

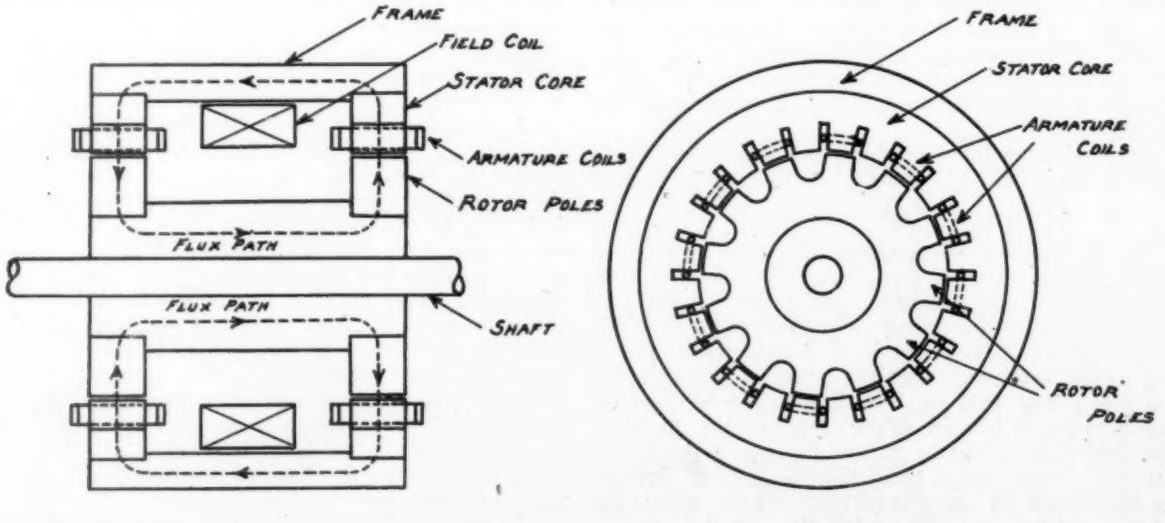


Fig. 2.—Diagrammatic Sectional Views of an Inductor Type Generator.

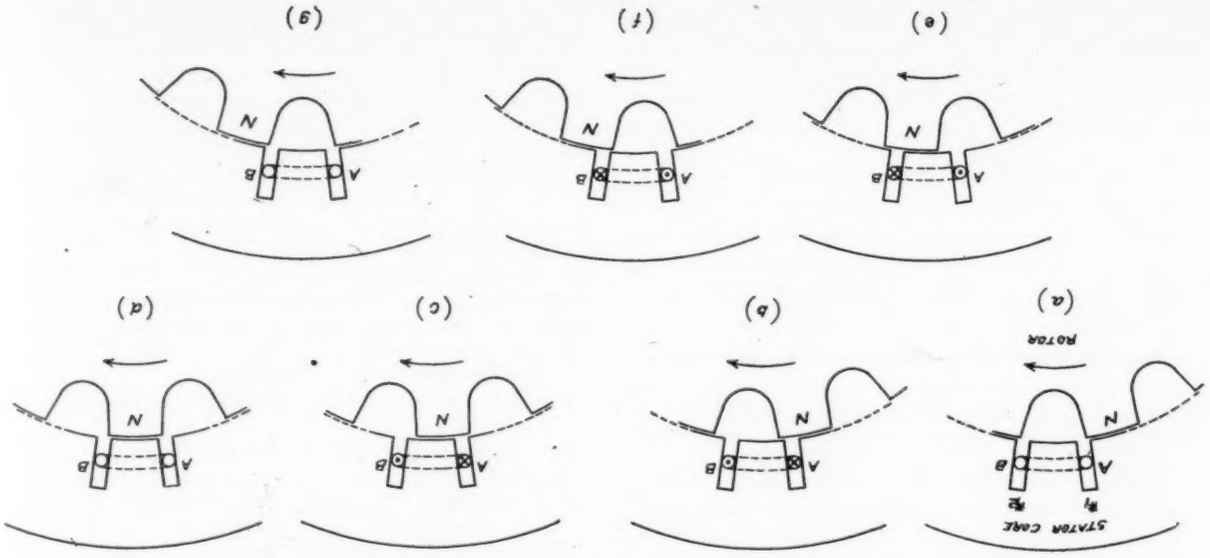


Fig. 3.—Diagrams Showing the Method of Operation of an Inductor Type Generator.

made tests from which the complete performance of the machine under any condition of load, voltage, power-factor, etc., can be determined. Such tests are as follows:

1. Resistance measurements.
(a) Armature (stator) resistance cold.
(b) Field resistance cold.
2. Armature (stator) reactance, rotor out.
3. No-load saturation and core loss.
4. Short-circuit test.

Resistance Measurements.—The resistance measurements are of the usual type and require no explanation.

Reactance.—The armature reactance of an inductor type machine is determined as follows: The complete revolving element is removed from the frame and an alternating electromotive force at a frequency corresponding to the normal rated frequency of the machine is applied to the armature terminals. Readings are taken of applied voltage and current, the voltage being varied sufficiently to cover a range in current from well below to considerably above the normal rated current of the machine. These readings are plotted in the form of a curve as shown in Fig. 5.

Since in machines of this type the resistance of the armature winding is small as compared with its reactance the impedance drop for any current, as obtained from the curve of Fig. 5, is very nearly equal to the reactance drop. Hence for most practical work the curve of Fig. 5 may be taken as representing the reactance drop in the armature winding. For most machines this curve is very nearly a straight line and it is therefore sufficiently accurate in most cases to take the reactance as determined from one measurement at normal current as a fixed value. If the machine, the curve for which is shown in Fig. 5, had a full-load current of 5 amperes, then its reactance would be taken as 77/5 or 15.4 ohms. At higher values of current, due to saturation, the reactance would be slightly less. The use of this value in predetermining the performance of the machine will be explained later on.

There has been considerable discussion as to just what is the most satisfactory method of measuring the armature reactance of such machines. The chief argument in favor of the above method is that it is a measurement which is quickly and easily made and furthermore it gives a value which enables the performance of these machines to be predetermined with considerable accuracy.

No-Load Saturation and Core Loss.—Data for the no-load saturation curve are obtained with the generator running at normal speed and with the armature open-circuited. The readings taken are field current and generator voltage. Such a no-load saturation curve is shown in Fig. 6.

At the same time that the readings for the no-load saturation curve are being taken, the input to the armature of the driving motor is usually noted. From this value the generator core loss is then obtained by deducting the resistance loss in the motor armature and the power required to drive the set with no field excitation on the generator. A core-loss curve plotted from data thus obtained is also shown in Fig. 6.

Short-Circuit Characteristic.—The armature-current curve of Fig. 6 is known as the short-circuit characteristic. Data for this curve are obtained by driving the machine at normal speed, short-circuiting the generator armature through an ammeter, and taking readings of the generator field currents and the corresponding armature currents.

Having obtained the three curves of Fig. 6 and the curve of Fig. 5, which may be termed the characteristic curves of the machine, and knowing the resistance of the generator armature and the field winding, the operation of the machine under any condition of load may be determined as follows.

Predetermination of Operating Characteristics.

In order to illustrate the method we will assume that it is desired to determine the operating characteristics of the ½-kilowatt machine, whose characteristic curves are shown in Figs. 5 and 6, on an output of 5 amperes at 125 volts, at zero power-factor, 80 per cent power-factor and unity power-factor.

From Fig. 5 the reactance voltage corresponding to 5 amperes is found to be 77 volts. Then the point *a* corresponding to 77 volts on the voltage scale of Fig. 7* is located and the horizontal line *ab*, which inter-

*In order to avoid confusing Fig. 6 with construction lines, the no-load saturation and short-circuit curves have been redrawn in Fig. 7.

sects the no-load saturation curve at *b*, drawn in. The field current *oc* is then the field current required to overcome the reactance voltage of the machine at the assumed load current of 5 amperes.

Next the point *d*, corresponding to 5 amperes on the ampere scale (of Fig. 7) is located and the line *de*,

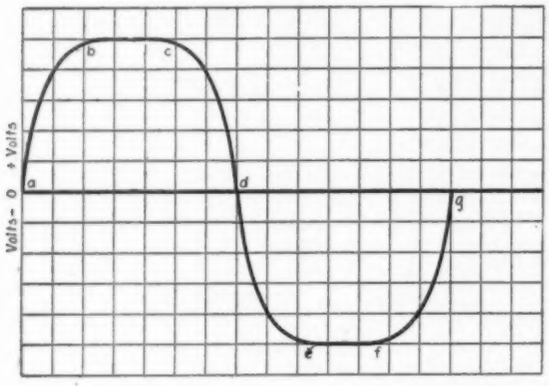


Fig. 4.—Instantaneous Voltage Curve for Inductor Type Generator.

which intersects the short-circuit current curve at *e*, drawn in. The field current *of*, corresponding to the point *e* on the short-circuit curve, is then the field current required to circulate a current of 5 amperes through the generator armature winding when this winding is short-circuited. Since the resistance of a machine of this type is small as compared with its reactance, the current on short-circuit is practically at zero power-factor, therefore the point *f* may be taken as one point on the 5-ampere, zero power-factor curve.

As is well known, the armature reaction of an alternator on zero power-factor is exactly opposed to the main field. Therefore, when the machine is operating at the point *f*, sufficient field excitation must be supplied to overcome the entire demagnetizing effect of the armature ampere-turns and to generate sufficient voltage to overcome the reactance drop in the machine corresponding to 5 amperes (resistance drop being neglected). We have already shown that *oc* is the field current required to overcome the reactance drop and therefore the remaining portion *cf*, of *of*, is the

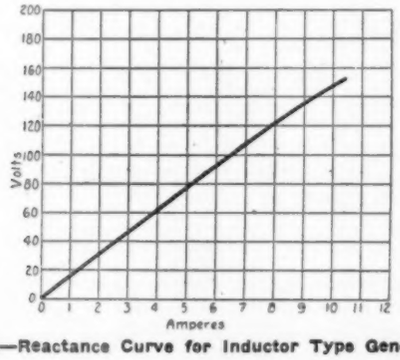


Fig. 5.—Reactance Curve for Inductor Type Generator.

field current required to overcome the armature reaction.

Other points on the zero power-factor curve may now be obtained by the well-known triangle method as indicated by the triangle *c'f'b'*, this triangle being similar and equal to the triangle *cfb*. The intersection of this curve with the line *gh* (corresponding to 125 volts) determines the field current *oi* required to carry a load of 5 amperes at 125 volts and zero power-factor. It is seen that if this load were thrown off (the field current remaining the same) the voltage would rise to the point *j* corresponding to 246 volts. The synchronous impedance of the machine on this load is equal to *ij* (volts) ÷ *ik* (amperes) = 246 ÷ 9.9 = 24.9 ohms.

We have now solved the first part of our problem.

In order to determine the performance of this machine under a load of ½ kilowatt at 125 volts, 5 amperes, and 80 per cent power-factor, it will first be necessary to construct the electromotive-force diagram shown in Fig. 8. The object in constructing this diagram is to determine the internal or generated voltage necessary to carry the above load. In Fig. 8,

E = terminal voltage of machine,
θ = angle whose cosine equals power-factor of the load,
RI = external (or load) resistance drop,
XI = external (or load) reactance drop,
rI = internal (or generator armature) resistance drop,
xI = internal (or generator armature) reactance drop,
E' = internal or total generated voltage.

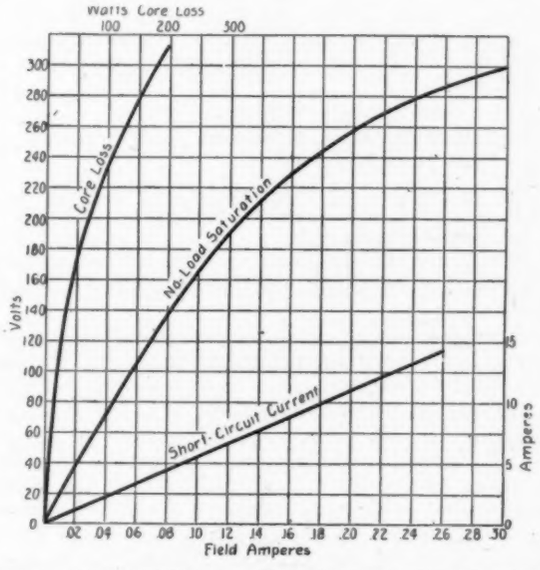


Fig. 6.—Characteristic Curves for Inductor Type Generator.

For the example given above,

$E = 125$ volts,
$\cos\theta = 0.80$, $\sin\theta = 0.60$,
$RI = 125$, $\cos\theta = 125 \times 0.80 = 100$ volts,
$XI = 125$, $\sin\theta = 125 \times 0.60 = 75$ volts,
$rI = 2.27 \times 5 = 11.35$ volts,
$xI = 15.4 \times 5 = 77$ volts,

$$E' = \sqrt{(RI + rI)^2 + (XI + xI)^2}$$
$$= \sqrt{(100 + 11.35)^2 + (75 + 77)^2}$$
$$= 188 \text{ volts.}$$

By locating the point *l*, corresponding to 188 volts, on the no-load saturation curve of Fig. 7, we obtain a field current *om*. This field current *om*, however, is not sufficient to carry the above load, for in addition to the field current required to generate the internal voltage (on no load) we must supply sufficient field current to overcome the demagnetizing effect of the armature ampere-turns. Unlike the zero power-factor case, on 80 per cent power-factor only a component of the armature ampere-turns is demagnetizing. The total field current required, taking into consideration this

demagnetizing component, may be obtained by means of the magnetomotive-force diagram shown in Fig. 9, wherein

$m'n' = om$ (Fig. 7),
$n'p' = cf$ (Fig. 7) (armature reaction),
$m'p'$ = total field current required.
$= \sqrt{(m'n' + n'o')^2 + (o'p')^2}$
$\Phi = \Phi$ Fig. 8).

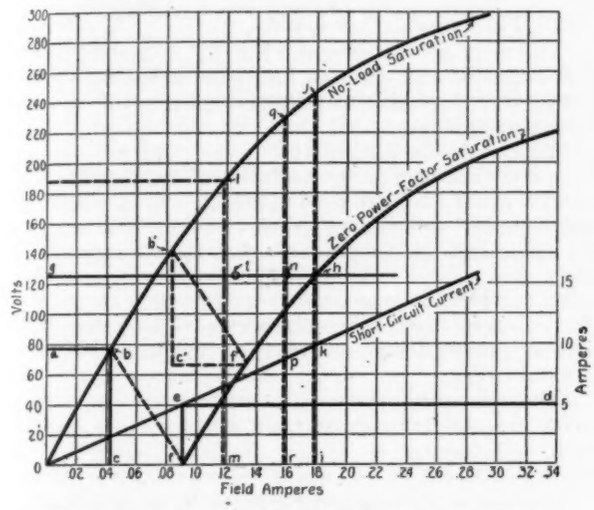


Fig. 7.—Method of Predetermining the Performance.

For the machine in question

$m'n' = 0.118$ ampere (field current),
$n'p' = 0.048$ ampere,
$\sin\Phi = (XI + xI) \div E' = (75 + 77) \div 188 = 0.808$,
$\cos\Phi = (RI + rI) \div E' = (100 + 11.35) \div 188 = 0.592$,
$n'o' = n'p' \sin\Phi$,
$= 0.048 \times 0.808 = 0.0388$ ampere,
$o'p' = n'p' \cos\Phi$,
$= 0.048 \times 0.592 = 0.0284$ ampere,
$m'p' = \sqrt{(m'n' + n'o')^2 + (o'p')^2}$
$= \sqrt{(0.118 + 0.0388)^2 + (0.0284)^2}$
$= 0.159$ ampere.

Having determined the value of $m'p'$ we may now locate the 80 per cent power-factor point n on Fig. 7 by taking gn equal to $m'p' = 0.159$ ampere. The synchronous impedance of the machine at this load is equal to $rq \div rp = 230 \div 8.7 = 26.4$ ohms. It is seen that if this load were to be thrown off the machine, the field current remaining constant, the voltage would rise to the point q corresponding to 230 volts. We have now solved the second part of our problem.

The procedure for determining the operation of this machine on a unity power-factor load is precisely the same as that outlined above for 80 per cent power-factor. The diagram of Fig. 8 now reduces to that shown in Fig. 10. The general shape of the diagram of Fig. 9 will remain the same. The point thus found is indicated as t in Fig. 7.

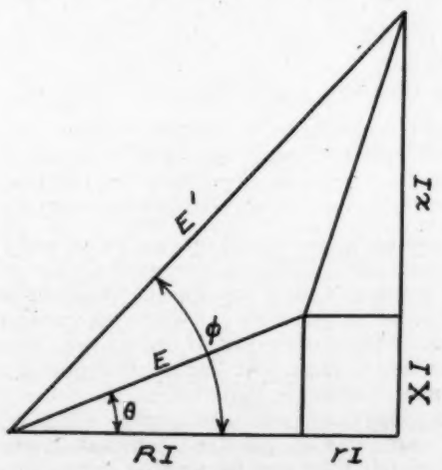


Fig. 8.—Electromotive-Force Diagram.

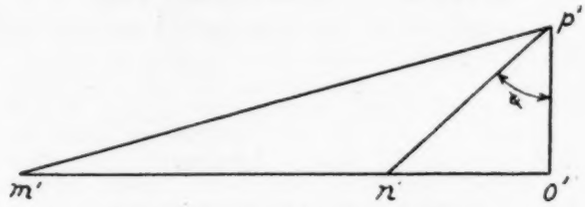


Fig. 9.—Magnetomotive-Force Diagram.

The performance of this machine under any other condition of load, terminal voltage, power-factor, etc., may be readily determined by following the method outlined above.

ELECTRICAL ORGANIZATION IN ENGLAND.

It has long been advanced in criticism of electrical organization in England that there are too many associations, also that there is no system in existence under which co-ordination of the useful ones which efficiently serve sectional interests, can be effected. There is now being formed what is called an Association of British Electrical Engineers which should assist in the direction desired. The first section is designed to safeguard the interests of all professional and technical men engaged in the electricity supply industry. Similar sections to follow will be for those engaged in other branches of the electrical industries of Great Britain.

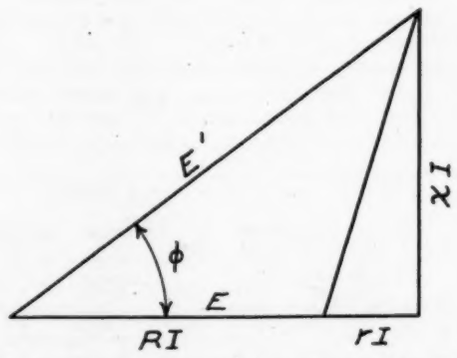


Fig. 10.—E. M. F. Diagram for Unity Power-Factor.

Each will have its own council, from which delegates will sit on a grand council, which will focus the activities of all engineers engaged in the electrical industries. The scheme has the cordial approval of the Institution of Electrical Engineers, which is about to call together in different parts of the country mass meetings of professional and technical men engaged in the business of electricity supply. The association will not be a trade union in any sense, but will follow the lines of such professional bodies as the British Medical Association, which assures the status of medical men.

GOVERNMENT SPECIFICATIONS AND TESTS FOR INCANDESCENT LAMPS.

New Specifications Available for Other Purchasers, Such as Central Stations.—Accelerated Tests.

The United States Government has always been one of the largest purchasers of incandescent lamps, but since our entry into the war its purchases have been on a still greater scale. The recently revised government specifications for incandescent lamps are therefore of special interest, particularly since their use, although general throughout the Federal departments, is not restricted thereto but is available to anyone interested.

For information regarding these specifications we are indebted to a paper recently presented before the Illuminating Engineering Society by Dr. M. G. Lloyd, electrical engineer of the Bureau of Standards. The Bureau has had very much to do with drafting these revised specifications, which will soon be published by it as Circular 13. Selected lots of lamps purchased by the Government are tested by the Bureau.

Most stress is laid in the specifications on specific consumption (watts per candlepower) and life. The life is considered terminated when the filament breaks or the intensity drops to 80 per cent of the initial value. The specifications call for an inspection at the factory for mechanical defects. A number of lamps are to be selected at random from each lot and sent to the Bureau for electrical, photometric and life tests. If more than the specified number fail on the test, the entire lot may be rejected. In emergencies, like the present war, a slight failing in quality below the standard limits may be made up by supplying an additional quantity of lamps. Limits are set for the voltage, current and candlepower. From the lamps chosen for test at least one sample is selected for life test; this must approximate the average of the test quantity. A second or duplicate lamp is reserved for life test in case of accidental breakage of the first lamp. Lamps broken during test are not included in the final average if the result would diminish the average performance. The variation of voltage on life test must not exceed ¼ per cent on either side of the nominal test voltage.

The accompanying table gives the standard specified rating and life performance for tungsten lamps. The spherical reduction factor for 110 to 125-volt vacuum lamps is 78 per cent; for 220 to 250-volt lamps it is 79 per cent. For gas-filled tungsten lamps the life is based at present on the reduction of the candlepower to 75 per cent of the initial; in normal times the limit is 80 per cent of initial candlepower as with vacuum lamps. A table similar to the one given has been made up for carbon-filament lamps, though the Government purchases only relatively few of them compared with its large purchases of tungsten lamps.

STANDARD VALUES FOR CLEAR 110 TO 125-VOLT VACUUM TUNGSTEN (OR MAZDA) LAMPS FOR MULTIPLE BURNING.

Size of Lamp in Watts.	Bulb Designation.	Rated Initial Watts per Spherical C. P.	Corresponding Initial Watts per Mean Horiz. C. P.	Initial Limits at Rated Voltage: Individ. Watts per Spher. C. P. Max. and Min.	Individual Total Watts Max. and Min.	Average Performance Test Life (Hours) to 20% Drop in C. P. at Rated Initial Watts per Spher. C.P.
10	S-17	1.67	1.30	8%	10%	1000
15	S-17	1.51	1.18	6	8	1000
25	S-19	1.41	1.10	6	8	1000
40	S-19	1.36	1.06	6	8	1000
50	S-19	1.33	1.04	6	8	1000
60	S-21	1.31	1.02	6	8	1000
100	S-30	1.26	0.98	6	8	1000
STANDARD VALUES FOR CLEAR 220 TO 250-VOLT VACUUM TUNGSTEN (OR MAZDA) LAMPS FOR MULTIPLE BURNING.						
25	S-19	1.65	1.30	9	12	1000
50	S-19	1.49	1.18	9	12	1000
100	S-30	1.39	1.10	9	12	1000
STANDARD VALUES FOR CLEAR 110 TO 125-VOLT GAS-FILLED TUNGSTEN (OR MAZDA) LAMPS FOR MULTIPLE BURNING.						
75	PS-22	1.09	....	15	18	1000
100	PS-25	1.00	....	12	18	1000
150	PS-25	0.92	....	12	15	1000
200	PS-30	0.86	....	12	15	1000
300	PS-35	0.78	....	12	15	1000
400	PS-40	0.82	....	12	12	1000
500	PS-40	0.78	....	12	12	1000
750	PS-52	0.74	....	12	12	1000
1000	PS-52	0.70	....	12	12	1000

METHOD OF TESTING THE LAMPS.

All lamps are tested at the Bureau of Standards on alternating-current circuits fed from a special transformer with a number of taps, giving the nominal voltages corresponding to the rating of the various classes of lamps. A small auxiliary transformer is supplied for each rack and taps are brought out so that the voltage can be adjusted to 0.2 volt. A 40-kilowatt, single-phase, 125-volt generator with Tirrill voltage generator supplies the transformers for the lamps and keeps the voltage within ¼ per cent. A recording voltmeter gives a permanent record of the voltage. An electric clock with relays is arranged to record the time of putting lamps on the life racks and removing them.

The life test is begun by determining the actual watts per candlepower at rated voltage; this specific consumption must be within the limits given in the table. To facilitate this test a special watts-per-candle meter is used. The initial candlepower of the lamp is also recorded on the card record for each lamp before the latter is put on the life-test rack. For carbon lamps candlepower tests are made at intervals of close to 100 hours; for tungsten lamps these tests are made at five definite periods during the estimated life.

Since a life test ties up considerable equipment for a long time, studies were made to determine whether the tests could be accelerated by running them at higher voltage provided a definite relation could be established between voltage and life. In the case of vacuum lamps this relation was definitely established and those lamps are therefore run at excess voltage, the obtained shortened life being corrected on the final record. It was found that the life varies inversely as the 5.83 power of the specific consumption (watts per candle) in the case of carbon lamps, and as the 7.4 power in the case of vacuum tungsten lamps. Similar relations were determined for variation of voltage and candlepower, current, and total watts. Equations were carefully worked out showing these relations for tungsten lamps. They have the general form

$$y = Ax^2 + Bx + c$$

where x is the logarithm of the voltage, y is the logarithm of the other related quantity, while A, B and C are constants.

These equations are as follows:

For watts per candle. $y_1 = 0.918x^2 - 2.009x + 0.07918$
For candlepower.... $y_2 = -0.946x^2 + 3.592x$
For watts..... $y_3 = -0.028x^2 + 1.583x$
For current..... $y_4 = -0.028x^2 + 0.583x$

In these equations the quantities x and y are given not in actual volts, watts, etc., but as the ratios of these to their nominal value; for specific consumption the nominal value is taken as 1.2 watts per candlepower. By means of these equations, if one knows the candlepower at any voltage, one can readily find it at any other voltage; likewise variation of the other quantities with voltage can readily be found. These relations are not applicable to gas-filled tungsten lamps as a class, although they can be worked out with appropriate constants for individual lamps.

Iron Wire for Transmission Lines

Importance of Considering Iron Against Copper—Relative Advantages of Iron and Copper—Probably Permanent Place for Iron—Abstracted from Paper Before Minnesota Electrical Association

By W. T. RYAN.

Assistant Professor of Electrical Engineering, University of Minnesota.

THE possibilities of the use of iron wire have been given very much more attention since war prices have forced the central-station companies to consider more carefully the initial investment required for transmission lines serving sparsely settled communities. Many rural copper-wire lines built to the standards used in well-settled districts will not at present prices return sufficient revenue to pay the overhead charges on the investment.

Iron-wire transmission permits the central-station companies to take advantage of the lower cost of conductors and the higher tensile strength, which means longer pole spacings and consequently smaller investment in poles and insulators. Poles, insulators and all kinds of line hardware have advanced so much in price that the reduction in the cost of the supporting structures by the use of iron or steel wires is almost as important an item in some instances as the saving in the wires themselves.

The San Diego Gas & Electric Company is using 550 and 700-foot spans with ¼, 5/16 and ⅜-inch standard seven-strand steel wires on its 11,000-volt extensions. It also has 52½ miles of ¼-inch steel in constant-current series circuits, as well as some 2300-volt iron-wire extensions. Three hundred fifty feet was the longest span it used with No. 6 copper wire and 450 feet with No. 2 or No. 1 hard-drawn stranded bare copper conductors. Shorter spans than the above would be required in Minnesota because of our severe snow, sleet, ice, wind and wide variations in temperature. In general, I think it is safe to say that the spans can be made at least 50 per cent longer if iron-wire transmission is adopted.

Cost of Conductors.

The capital expended on conductors depends upon the material and the total weight. The weight of the conductors necessary to transmit a certain amount of power over a definite distance will, of course, depend on the voltage and, apart from the engineering difficulties encountered at higher voltage, there are economic considerations which determine the maximum voltage suitable for any given conditions. Among these may be mentioned a possible increase in cost of generating equipment, the greater cost of stepup and stepdown transformers, of control apparatus, insulators and of line poles and towers because of the wider spacings between conductors. Then again with extra-high voltages there is increased charging current and possible corona and hysteresis and eddy-current losses.

Given a definite amount of power to be transmitted and a definite voltage, the current can be calculated. The most economical size of conductor is proportional to the current and independent of the electromotive force. The load-factor, which gives us the ratio of average load to maximum, does not give us the average I^2R loss as compared to the maximum I^2R loss. The current should be figured as the square root of the mean squared value for copper-wire transmission. The square root of the mean squared value is about 1.11 times the average value. With iron-wire transmission R increases with the current. The resistance at the average value of the current will usually be about the right value to use.

The economical size of wire is such that the annual cost of the energy wasted per mile of the transmission line, added to the annual allowance per mile for annual charges on first cost shall be a minimum.

If we assume that the cost of poles or towers, insulators, and cost of erection of the line is independent of the actual size of conductor, then the only variable

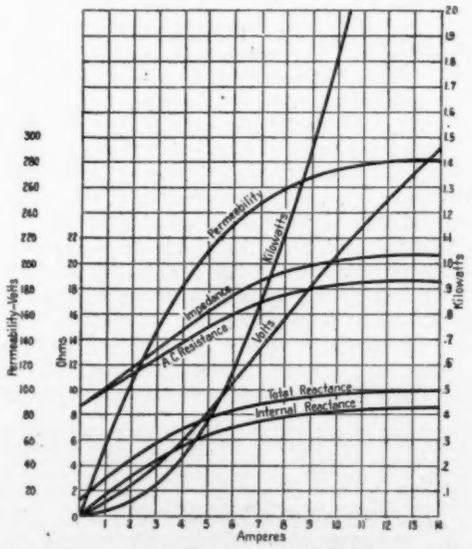


Fig. 1.—Constants Per Mile for No. 6 BWG Galvanized Iron BB Wire. 60 Cycles. 30-Inch Spacing. 20° C.

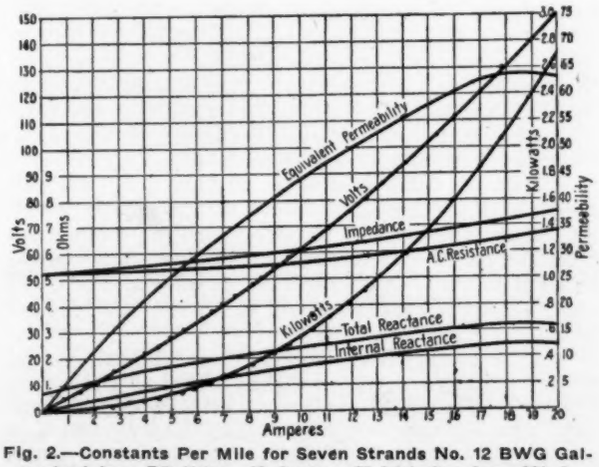


Fig. 2.—Constants Per Mile for Seven Strands No. 12 BWG Galvanized Iron BB Wire. 60 Cycles. 25-Inch Spacing. 20° C.

item is the capital expended on conductors and this item will be directly proportional to the weight of the conductor. The I^2R loss will be inversely proportional to the size of the conductor. Kelvin's law for maximum economy states: *The most economical section of conductor is that which makes the annual cost of the I^2R losses equal to the annual interest on the capital cost of the conductor material, plus the necessary annual allowance for depreciation.* If the current is large, we may have to use a larger wire in order to give reasonably good regulation. If the current is small, we may have to use a very much larger wire for mechanical reasons.

Let us assume that a certain small town 10 miles distant has a maximum load of 80 kilowatts at 13,200 volts, three phase, 60 cycles, and that the load-factor

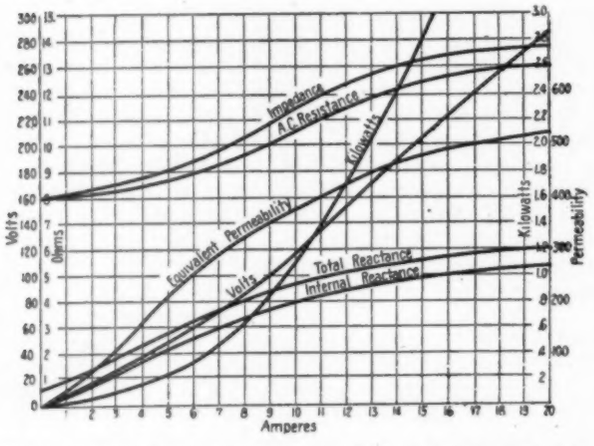


Fig. 3.—Constants Per Mile for Three Strands No. 10 BWG Galvanized Iron BB Wire. 60 Cycles. 25-Inch Spacing. 20° C.

is 30 per cent with an average power-factor of 85 per cent. This gives us a maximum load current of 4.15 amperes. If we assume No. 6 wire spaced 36 inches on an equilateral triangle, the charging current will be 0.47 ampere. At full load this will reduce the 4.15 to about 4.1 amperes. Increasing this by 11 per cent to give us the square root of the mean squared value we get 1.49 amperes. We will assume that it costs 0.8 cents a kilowatt-hour to put energy on the line, that copper wire costs 40 cents a pound, and the annual charge on the line is 10 per cent. Applying Kelvin's law we get a No. 12 copper wire. For mechanical reasons we will be compelled to use a No. 6 copper wire, and the cost of our conductors will be $5028 for the ten miles. The line loss on maximum load will be only 42 watts per mile per wire, or 1.36 kilowatts on the entire line. The voltage regulation on maximum load will be about 1.7 per cent. The voltage regulation with the No. 12 wire would have been satisfactory if we could have used it.

Three No. 6 BB iron wires 10 miles long will cost about $900 as compared to $5028 for copper wires. At the average load the resistance will be 11 ohms per mile, and at the maximum load 14 ohms. The equivalent I^2R loss at full load will be 7.2 kilowatts or 9 per cent. The line regulation will be approximately 9 per cent.

At the average load the line loss will be only (1.35) $2\times11\times30=610$ watts, or slightly less than 1 per cent.

A ¼ or 5/16-standard steel cable would be suitable for this line. The 5/16-inch cable would cost about $1000 and the I^2R loss at full load would be less than 7 per cent. To the $4028 saved on line wires would be added another considerable saving since the spans could be increased, say, 50 per cent.

If the maximum load on the above line were 500 kilowatts, No. 6 copper wires would be required by Kelvin's law and for good voltage regulation. Under these conditions iron wires would cost nearly twice as much as copper wires and the longer spans would be offset by the necessity for heavier supporting structures for the larger iron wires.

Relative Advantages of Iron and Copper.

The relative advantages, from the standpoint of economy, of iron and copper on alternating-current lines are difficult to determine because the alternating-current resistance of iron conductors varies widely with the current and with the grade and makeup of the wire. The alternating-current resistance of a conductor depends upon its magnetic properties, and as a general rule the better the iron the more the resistance will vary with the current density because of the higher magnetic permeability of the higher grade iron. The resistance of a No. 6 copper wire is almost exactly the same with 1 ampere of 60-cycle alternating current flowing through it as it is with 5 or 50 amperes. The resistance as measured with direct current of a No. 6 EBB solid iron wire is 8 ohms per mile. The resistance with 7 amperes 60-cycle current is 20 ohms, a rise of 150 per cent. For still larger currents the resistance falls off slightly. The direct-current resistance of No. 6 BB solid wire is 9.6 ohms. The alternating-current resistance with 12 amperes 60-cycle current is 18.9 ohms, a rise of 96 per cent. The alternating-current resistance of a 5/16-inch, seven-stranded, galvanized-steel cable is only 20 per cent higher with 15 amperes 60-cycle current than it is with direct current.

The economical advantages of iron wires for short high-voltage lines are now receiving very careful consideration. Iron wire is, of course, much better from a mechanical standpoint but at a great disadvantage as regards conductivity and durability. The internal inductive reactance of iron wire is many times that of copper. This is not a serious consideration on very short lines. On lines that would be considered long for iron-wire lines and with higher voltages this factor may involve serious variations in the voltage.

On voltages of 40,000 and above, and on lines, say, 30 or 40 miles long and above, the charging current is so large and the self-induction of the line is so large that the voltage regulation varies widely between no load and full load, and the current for which iron wires show a real saving is so small that it is doubtful if the line would be built at all unless there were sufficient load to call for copper-wire transmission.*

When we take into consideration the very long spans which may be used, steel conductors would show a very decided saving on many constant-current series street-lighting circuits. A seven-strand 5/16-inch steel cable has an alternating-current resistance of 6 ohms per mile at 6 amperes and 60 cycles. The voltage drop in 10 miles would be only a little over 360 or less than 10 per cent on a 4,000-volt circuit. If many of the existing copper-wire street-lighting lines

*At this point in the paper Professor Ryan introduced many of the data and characteristic curves that were included in his article on "Iron Wire for Short High-Voltage Lines," which was published in the ELECTRICAL REVIEW of September 22, 1917, pages 496-500. In it were included a summary of the tests of the Flandreau-Elkton iron-wire transmission line of the Dakota Light & Power Company, comparison of the effect of iron and copper on line-voltage characteristics, discussion of the kinds of iron wire to select from, and a statement showing that iron wire is worth considering even in normal times, since the ratio between the price of iron and copper is about the same at times of low as of high prices.

were replaced with steel cables, every other pole could be taken out.

Copper wire is not indispensable in electric power transmission. For long extra-high-voltage lines, aluminum is sometimes cheaper than copper. The Germans are reported to have discovered an alloy of zinc which combines ductility and toughness with fair electrical conductivity. In some cases they have even used iron wire covered with a double coating of good varnish instead of the ordinary form of insulated wire.

The Bureau of Standards, Washington, D. C., will in the very near future publish the results of its study of iron-wire transmission, and will give data on which to base sags and tension in the spans. There is no

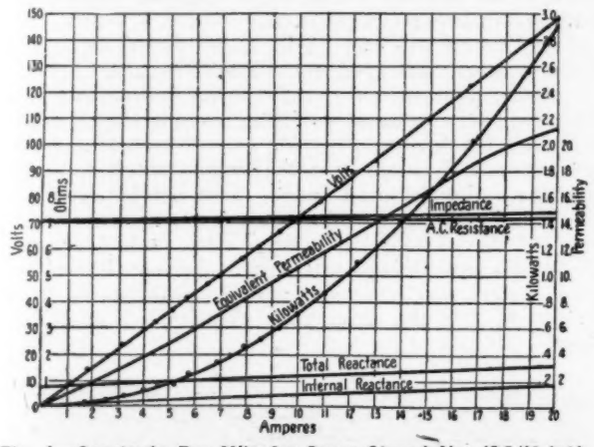


Fig. 4.—Constants Per Mile for Seven-Strand No. 12 5/16-Inch Siemens-Martin Steel Cable. 60 Cycles. 60-Inch Spacing. 20° C.

question but what iron wire is considerably stronger than even the best hard-drawn copper wire, also that the variation in the tension and sag will be somewhat less than with copper wire. The Central Connecticut Light & Power Company has put three No. 4 B. B. iron wires on poles in two instances 480 feet apart. A sleet storm which broke a number of telegraph wires on poles 125 feet apart did not affect this installation.

Obviously longer spans, therefore fewer poles, crossarms, pins, and insulators, may be used. Sometimes the liability to rusting is viewed with alarm. If small iron telephone wires are safe for from ten to twenty years, the larger wires will have a longer life, since the larger the diameter, the less the relative surface exposed to rust compared with the weight. Furthermore, although nearly all the 600-volt trolley wires suspended over the heads of pedestrians in busy streets are supported by stranded galvanized-iron wire, casualties due to the rusting away of these wires seldom occur.

Ripon Light & Water Company, Ripon, Wis., and its subsidiary companies, namely: Green Lake Electric Company, Kingston Electric Company, Markesan Electric Company, Wisconsin Light & Power Company, furnishing light to Rosendale and Eldorado, have been taken over by the Wisconsin Power, Light & Heat Company of Chicago. The new owners plan for the present to operate the properties as a separate group with the present employees, the only change being the appointment of a new general manager in place of W. E. Haseltine, who is now in service. The company is building a power line from the generating station at Kilbourn to connect up the Ripon group of properties.

PRESIDENT URGES ENGINEERING PREPARATION IN UNIVERSITIES.

Army and Navy Calls for Services of Many Advanced Engineering Students.

The March number of the *Michigan Technic,* issued by the College of Engineering, of University of Michigan, Ann Arbor, contains a facsimile letter from President Wilson, urging preparation in engineering as a means of helping carry on the war and of aiding in reconstruction after the war. The President's letter came as the result of resolutions prepared by a committee composed of members of faculties of several institutions as follows: Dean F. L. Bishop, University of Pittsburgh; Prof. C. R. Mann, Carnegie Foundation; Prof. A. E. Kennelly, Harvard University and Massachusetts Institute of Technology; Dean M. E. Cooley, University of Michigan, chairman.

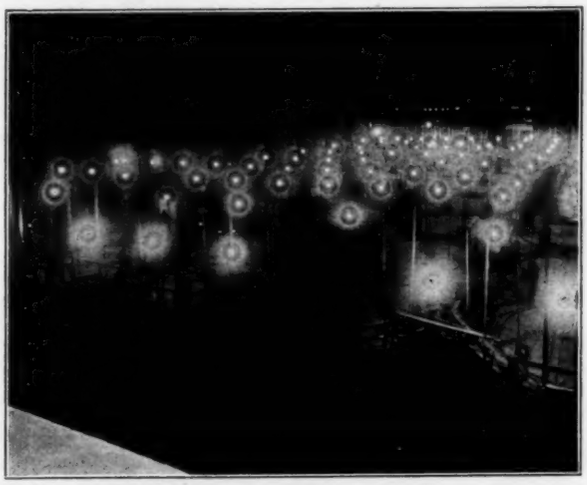
In the University of Michigan the attendance in the engineering department has fallen off 25 to 35 per cent, and probably the same is true of other colleges. Calls are continuous from the Army and Navy for the services of the more advanced students in engineering and it is predicted that graduating classes this year will not be more than half their numerical size.

The average age of engineering graduates in this university is 23 years,

The establishment of the Engineer Enlisted Reserve Corps and Naval Reserve Force at this institution, it is thought, will keep many in the college, there being 250 to 300 upper classmen in these reserves.

LIGHTING AN ELEVATOR CONTRACT JOB.

In building a concrete elevator or grain storage work must progress night and day with practically no interruption. This for the reason that great integrity is demanded of the structure because of immense



Lighting of Grain Elevator During Construction.

pressures existing after the tanks are filled. To gain this, fresh concrete must be poured onto concrete that has not been allowed to stand over an hour or so.

Moving forms are used as in the case of the 2,000,000-bushel grain storage of the Quaker Oats Company at Cedar Rapids, Ia. On these forms scantlings are erected as masts to carry a great number of incandescent lamps as shown in the accompanying view. The Leonard Construction Company of Chicago, Ill., was the contractor on this work.

Interesting Electrical Features of Chicago's Evangelistic Tabernacle

Low Initial Cost, Temporary Character of Structure, and Endeavor for High Salvage Combine to Effect Unique Features of Wiring

THE SUNDAY tabernacle in Chicago, erected for the three-months' evangelistic campaign by William Ashley Sunday, possesses a number of interesting features. The structure is only a temporary one, the duration of the campaign is to be three months. It has a seating capacity of 12,000 persons, with standing room for 4000 more, was erected hurriedly, and is to be dismantled at the completion of the campaign with as high a salvage as possible. The tabernacle is made entirely of wood, a large portion of which is of finished surface on account of acoustic properties, the endeavor being that there shall be as little interference with sound waves as possible.

A number of electrical features of the tabernacle stand out prominently. The work is almost entirely of the open variety. Another fact is that the form of construction is what might be considered as the application of outdoor construction to indoors, the interior wiring approaching in similarity that often employed for outdoor secondary distribution. Although open wiring is used, it is not of the usual cleat and knob variety, but instead brackets are used for supporting both conductors and light units.

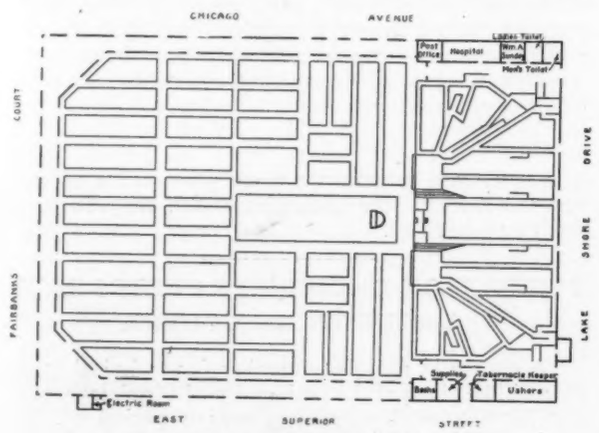
Service to the tabernacle is furnished from the underground mains of the Commonwealth Edison Company, with three-wire 220-110 volts direct current. The main service panel is of slate mounted upon angle iron and carries one two-pole service switch and ten 50-ampere two-pole single-throw switches, each equipped with enclosed fuses. This service board is enclosed in standard steel cabinet with two doors opening full size of cabinet and fitted with vault door handles. An entirely separate service cabinet, having its own meter, service switch and distributing board is employed for the emergency circuits, as described later.

Gereral View of Interior Lighting, Sunday Tabernacle, Chicago.

There are nine sets of three-wire feeders running from the service board to the nine cabinets situated at different locations throughout the tabernacle. Five of these cabinets control the general lighting, two exit and corridor lighting, and one the restaurant and comfort station lighting in adjacent structures and one the outside lights. Four of the feeder cabinets for general lighting and that serving the restaurant and comfort stations are of No. 6 Simcore wire; one short circuit for general lighting and the exit and corridor lights are supplied by No. 10 wire, while the outside lights use No. 8 Simcore wire throughout.

All feeders are three-wire, while all circuits are two-wire. There are 11 cutout cabinets controlling the various distributing circuits. These cabinets are mounted upon slate panels enclosed in standard steel cabinets. All cabinets are equipped with spring hinges and Yale locks.

Both feeders and distributing circuits are carried upon National brackets (No. 5003). This is a three-insulator bracket, the insulators being bolted to the galvanized iron base by a U-bolt, one to each insulator.



Plan of Sunday Tabernacle, Chicago.

These bolts may be inserted in any of several positions according to the direction of travel of the conductors passing through the insulators. The bracket base is fastened to the roof rafters by nails. The spacing of rafters, and therefore brackets, is 16 fet. Because of the spacing between brackets, namely, 16 feet, No. 12 wire is used for all distributing circuits. The two conductors of each distributing circuit are carried on the two outer insulators of the National brackets, while the central insulator acts as a strain or suspension insulator for the lighting unit or pendent fixture. The pendent fixtures for general lighting are composed of National X-Ray beehive reflector No. 570 and tungsten lamp. While the sizes of these lamps are mostly each of 100 watts, the fixture over the preacher's platform is 500 watts, carried by a National X-Ray beehive reflector No. 580. The customary pipe stems of all fixtures have been dispensed with and the light units are instead supported from the center insulator of the National bracket by No. 14 brewery twisted-pair cord. The toilets and offices are equipped with Hubbell sockets, while those for the offices have pull chains. For the corridor and exits keyless receptacles with porcelain bases screwed to the walls and partitions or of the weatherproof variety, as the case may be, are employed.

To prevent accidents due to fuses blowing, fires, cranks pulling switches or cutting wires, and so on, special precautions have been employed to prevent the tabernacle from being plunged in darkness. An emergency service is provided, separate and isolated from the main service to the tabernacle. This emergency service has its own service switch, meter and control cabinets from which circuits supply corridor lights, exits, portions of the main assembly room and Billy Sunday's private quarters. In this way, if the main service was interrupted, the tabernacle would still be sufficiently well lighted to permit safe movement of the audience and protection of the speaker and preclude the chance of panic. Altogether there are three cabinets for the emergency lighting. The lights at the exits are dipped in red, to indicate exits.

The connected load, aggregating about 42 kilowatts, is made up of the following lamps:

350 100-watt lamps.
75 60-watt lamps.
40 40-watt lamps.
1 500-watt lamp.

The work of erecting the tabernacle was quickly carried out, and it is expected that when the time comes to disassemble it that there will be a very large amount of material available for use again, and none the worse for its use in the present instance. The methods employed for the wiring aimed at absolute safety, low initial cost and high salvage. The form of wiring employed has been found entirely adapted to conditions; in fact, the really quasi-outdoor construction methods have proved to be satisfactory, since the roof is not entirely rainproof.

The wiring of the tabernacle brought out very favorable comment, as has also the illumination. The tabernacle was designed by Holabird & Roche, architects, while the wiring was executed by the Freeman-Sweet Company, both of Chicago.

NEW COMMITTEE TO CONSIDER BRITISH ELECTRIC SUPPLY PROBLEMS.

The Council of the Institution of Electrical Engineers has nominated C. H. Wordingham, director of electrical engineering at the British Admiralty, as its president for a second year. Two eminent electric power supply men are named as vice-presidents—W. A. Chamen, engineer of the South Wales Electric Power Company, and R. A. Chattock, city electrical engineer of Birmingham. The three experts named form a distinguished electric supply trinity for a year in which the question of national electric supply reorganization and development will be continuously to the fore. Mr. Wordingham was once city electrical engineer of Manchester. Mr. Chamen was formerly in a similar capacity at Glasgow, and Mr. Chattock, now at Birmingham, has one of the greatest English municipal electricity undertakings in his charge.

UTILITY COMMISSION REQUIRES NEW GAS INSTALLATIONS.

The State Public Utilities Commission has issued an order requiring the Public Service Company of Northern Illinois and the Peoples Gas Light & Coke Company, both of Chicago, to continue to make new gas connections. They are allowed, however, to require a deposit from new customers to cover the cost of such connections, which amount will be refunded at the rate of 25 per cent a month, with interest at the rate of 5 per cent per annum.

Some must go. All must give. Buy Thrift Stamps and War Stamps at every opportunity. Only some may fight with arms. But we can all aid the cause with a barrage of money.

UTILITIES AND THE WAR.

Abstracts from a Valuable Paper, Dealing With Existing Conditions, Read at Wisconsin Electrical Convention.

That 6 per cent, or a little above the current interest rate in a community, is deemed a reasonable return on utility capital is being proved a fallacy, according to conclusions set forth by M. C. Ewing in a paper read before the Wisconsin Electrical Association, at Milwaukee, March 27 and 28. Mr. Ewing is secretary-treasurer of the Wisconsin Valley Electric Company, Wausau. A summary of portions of his paper is as follows:

For years past every progressive company has pursued an optimistic and liberal policy with respect to furnishing additional service and securing additional customers. Development and progress has in the past been the universal utility aim. This policy has required an endless stream of new capital, and rare is the company whose net earnings have provided funds out of the profits of the business for extensions to property and to plant accounts, but rather has it been necessary to provide new capital, by the sale of additional securities; and the net earnings have been maintained at an irreduceable minimum, for even under normal peace times. The highest court of the land, in one instance at least, has decreed that 6 per cent was a reasonable return upon utility capital, and substantially all decisions of regulating bodies, when analyzed, have in practice declared that a reasonable return was little above current interest rates in the community where supplied. This reasoning is now being proved a fallacy.

Discussing war conditions, Mr. Ewing says:

The unprecedented increase, in the cost of furnishing utility service, found the companies bound down with iron laws, and public prejudice against utility rate increases, so that increases for utility output to meet increased costs of production has been denied the utilities, while open to all private industrial institutions which have availed themselves not only of necessary increases, but in many instances have advanced their prices far beyond the point of necessity.

The prosecution of this war and the possibilities of other international complications demand the furnishing by the utilities of every demand for power, heat and transportation required for the essential industries or for the successful arming and maintaining of our army and navy as well as for our domestic necessities. The demands for electric power for war purposes have been great and they may be greater; this power must be furnished whenever and wherever demanded and the credit of the utilities must be kept high. If private management cannot meet the test, the utilities must follow the railroads and be taken over by the government.

The first and primary consideration of the utilities is sound credit, and sound credit is only possible with adequate net earnings, and adequate net earnings is only possible with advanced rates and it is the solemn and urgent duty of the managements of the utilities to at once demand, rather than to petition, for rates which will adequately meet this unparalleled condition. We do not want them in two years; we want them now. There is no class of industries which can show a greater efficiency of operation than the utilities of America. Every effort should be made to connect for the interchange of power the various electrical plants and systems of the state and nation. Only those who have already made such connections appreciate the benefits and economies possible.

We need waste no time in pointing out in detail our still rapidly rising costs. Every one understands that our period of rising costs will not be fully reflected in our statements of 1917. They will seek a higher level during the next 12 months.

In reference to maintenance the following pertinent declarations are made:

The utility properties must be kept in a high state of efficiency now and at all times. Every effort must be made to use so far as possible the materials at hand, but our equipment must not be permitted to deteriorate into an inferior condition. It must, on the contrary, be kept in the highest state of physical condition, to meet the unusual demands which are to be made upon it.

And what is our duty with respect to our trained men? Private business with its higher levels of net earnings is paying, and can possibly for a time afford to pay, wages to men which seem almost prohibitive to the utilities. The time is coming, and it may not be far distant, when this condition will no longer prevail and it may be reversed. Year in and year out the utility employments are a safe, sure and lucrative employment, and it should be pointed out that in the past, when factories were idle and when soup houses were common, as they will be common again, that the utility employment continued without change 365 days a year. In the meantime, we should so far as possible pay our old and reliable employes as nearly the general industrial level, and substitute women wherever it becomes necessary to fill the vacancies which may occur by draft or otherwise.

PITTSBURGH UNIVERSITY OFFERS RADIO ENGINEERING COURSE.

A course in radio engineering for technical graduates will be given at the University of Pittsburgh, starting May 20 and extending over a period of eight weeks. This will be open only to graduates in electrical or mechanical engineering who are recorded in Class I of the National Army draft. Men enrolling in it will be placed by the Government in Class V until completion of the course, when they will be inducted into the Signal Corps and sent to an army school for further training. The need for men familiar with the technique of radio communication is great and the chances for obtaining commission ultimately are very good.

There is no charge for tuition, but students must provide their own living and travel expenses. As the number of men is limited, application should be made at once to Prof. H. E. Dyche, Department of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa.

MACHINE TOOL TRADES FORM LIBERTY BOND COMMITTEE.

Representatives of the machinery and machine tool trades of Greater New York have organized a special committee for promoting the sale of Liberty bonds in this field. The committee, a part of the Rainbow division of the Liberty Loan Committee, with headquarters located at 334 Fourth Avenue, New York City, is comprised of 48 members, many of whom are prominent in the machine tool industry. Those actively in charge of the work are J. W. Lane, chairman; R. L. Patterson, vice chairman; Charles B. Houston, secretary; Charles A. Hirschberg, publicity director, and Norman Dodge, director of speakers.

Editorial Comment

Industrial Application of the Synchronous Motor

CONSERVATION is now being applied toward almost every expenditure of effort, time and material in the desire to do more in less time. Central-station companies have long since had their loads restricted because of lack of capacity or fuel, or both. Enforced economies in the way of cessation of needless plants, lightless nights and so on are the order of the day. With conditions as they now are, low power-factor and the loading up of equipment by needless wattless current is no longer to be tolerated with the same patience that it was in pre-bellum days, when capacity was not so hard pressed as it is today.

Figured back to the coal pile, low power-factor has always been expensive. But today it is anathema to the cause of economy and efficiency, when all useless expenditures of energy and needless wastes are being sought out and eliminated under the insatiate requirements of war. Low power-factor, therefore, like the enemy in our midst, should be remedied wherever feasible. These days when loads cannot be connected up because of shortage of capacity, wattless current, which is not wattless when figured back to the coal pile, and when considering heating and loading up of turbines, exciters, generator windings and conductors, becomes a menace, and its reduction imperative.

In the past, wattless current and low power-factors, in fact, any power-factors that happened, were quite generally accepted as a matter of course. But today under the stress of war, it is forcibly emphasized that the reduction of wattless current means economy of capacity and fuel—and both are vital needs. This being so, attention turns to reducing the wattless current. And in doing so, like so many other things since the war, the tendency is to go straight at the problem to the root instead of where more convenient and easy but less efficient. The place to correct for low power-factor is where the low power-factor occurs, which is where the load exists. For example, if low power-factor is due to a number of induction motors lightly loaded, the place to correct for the power-factor is at the motors and not at the generating station with its intervening transmission lines, thus reducing losses throughout the system and improving operation and efficiency in general. This is one reason why the synchronous motor is finding increasing adoption for improving commercial power-factors, namely, that it can be located where needed, which, after all, is the logical place, since the customer may correct for his individual power-factor, whilst the central station manipulates the over-all power-factor of the system.

The synchronous motor today is being mobilized in the nation's cause in raising the power-factors of many industrial plants. One by one the characteristics of the synchronous motor have been better adapted to commercial uses, until today it is possible to obtain it with characteristics very similar to the induction motor within certain limits. And within these limits it is quite feasble, and often desirable, to use the synchronous motor in place of the induction motor. High pull-out torque, low pull-in torque, stable running and reasonable starting characteristics are now obtainable, with which go, of course, higher efficiency, constancy of speed independent of voltage variation, flexible control of power-factor, and greater choice of speeds. In the matter of initial cost, floor space and amount of skill or attention required the synchronous motor is at a disadvantage to the induction motor. But these disadvantages are not as serious as might be at first supposed, because where it is financially feasible to correct for power-factor it is policy to use the synchronous motor also for mechanical applications, which absorbs part of the cost.

As the design of the synchronous motor for industrial purposes is somewhat of a compromise, as are all things, between high starting torque on the one hand and low pull-in torque on the other, certain applications naturally suggest themselves as being particularly well adapted to synchronous motor drive. Since starting is, fundamentally, the weak feature of the synchronous motor, and since power-factor control and efficiency are the strong features of its running, it is natural to apply the synchronous motor where it will not be called upon for frequent starting. On the other hand, with its starting characteristics it is well able to drive apparatus requiring low as compared with high running torque, obtainable by shifting the load or by unloaders. Some of the more obvious applications are air and ammonia compressors, blowers, pulverizers and rock crushers, centrifugal pumps and any other form of drive where the load may be increased after full or synchronous speed has been attained.

It has often been claimed there is a motor for every purpose. And there are many purposes where the synchronous motor can be very usefully employed instead of induction motors, for improving power-factor and extending the limitations as to capacity and voltage regulation low power-factor imposes on apparatus and performance. Power-factor correction should more often be placed upon a dollar and cent basis, whether as affecting rates for energy or as concerning investment and operating expenses of existing plant or for extensions. And on this basis, making it a business proposition throughout, the synchronous motor deserves even greater consideration and wider application than it is receiving.

The Portable Substation

PERHAPS one of the most commonplace features at the present time is the unexpected. So many unexpected things have happened that people are becoming accustomed to, and are prepared for, the unexpected. The central station has long been accustomed to being prepared for the possible, the peak load that comes daily and that may come with changeable weather, by having available equipment and capacity for the loads that may come and before they actually occur. However, since the war even the central stations have been taxed to the limit in attempting to meet exceptionally heavy loads in unexpected places and at unexpected times. Munition factories have sprung up, army cantonments have come into being, and so on, necessitating service on short notice and of exceptional load-factor and magnitude.

For meeting many forms of load that change from time to time and from place to place it is desirable to have equipment that may likewise be moved quickly from place to place as is required. Equipment arranged so that this is possible is usually called a portable substation. In the past, the portable substation has been used quite widely, but mainly by electric railway companies, because of the necessity of employing converting apparatus and the large amount of apparatus necessary to convert from alternating to direct current. Nevertheless, the portable substation may often be of great value to the central station, for many central stations operate street-car systems, while many more furnish the energy for operating them. And there are other instances where the portable substation may be of use entirely apart from electric traction.

At these times when housing problems exist, when publicity is being given the inability of electric railways to haul the large masses of munition workers to and from work because of limitations imposed by their transmission systems and rolling stock, and the threats of the Government to take over and operate traction utilities that fail to furnish the required service, the portable substation suggests itself as a possible partial solution for more than one handicapped system.

There are many places where the portable substation has saved far higher investment in copper than would have been necessary without it. It serves the place of copper, with the advantage that it may be moved from place to place as needed, and on short notice, and without deterioration, whereas copper can not be strung, taken down and restrung elsewhere without deterioration, loss of time and at considerable trouble. Moreover, the portable substation does not deteriorate through movement, whilst conductors kink and break and become brittle if handled often, not to mention the waste of material and labor. The portable substation is flexible and efficient, convenient and widely applicable. Wherever there is the overhead transmission line or underground conductors and the space for the station, there the portable substation may be installed so long as its use is required. During prebellum days the race course, the amusement park, band-stands, the lake and sea shores, steep grades at special times—these called the portable substation into use. Today with the country at war there are the drill grounds, the National Army training camps, munition factories, and so forth, where loads have sprung up and require methods of meeting them, a short but severe peak—some regular, some transient.

Another use of the portable substation that has proved of extreme value in more than one instance is where apparatus in a substation becomes ineffective for long periods due to burnouts, and the portable substation can be moved to replace the stationary equipment that has become inoperative.

The need for converting apparatus and the conditions to be met have resulted in the portable substation finding greatest application for electric railway service. However, other uses are cropping up. One such application of the portable substation that has not received nearly the attention that it ought in these times of forced outputs under serious handicaps is that of the mine. A substation should be preferably located at the center of gravity of its load. In most mines the substation is located at the mine head. As the workings extend, distribution losses increase, voltage regulation becomes worse, hindering output, overloading machines and causing burnouts as well as many delays and lost motion. A portable substation in the mine moved as conditions dictate with gradual growth or transient activity locally is able to relieve overloaded copper, increase production and usually lower operating costs.

The electric welding outfits, another specialized form of portable substation, will doubtless find their way in increasing numbers where riveting is giving place to welding, and the oxy-acetylene flame to electric cutting. Another form bordering on the outdoor substation is the control, transformer and meter installations often used by central stations for supplying energy for construction purposes by contractors.

It is cheaper and in every way better, where circumstances permit, to have equipment adaptable for movement from place to place as required, than to have it stationary, often unused for long periods, and not earning a return nor serving useful purpose other than being in readiness to serve.

Which Will You Choose?

WHICH will you choose?

The Government needs all the money, material, and labor it can get, and more. This is a war of equipment. No matter how brave our men are, they cannot face the greatest military organization the world has ever known with bare hands. There is not enough labor and material in the country for our usual comforts and luxuries and for our fighters' necessities. We must choose which it shall be. "Back up the Boys." Buy Liberty Bonds.

Week's Events

Wisconsin Electrical Contractors Meet—Engineering Council's Activities—Water Power Development Need Shown

N. E. L. A. CONVENTION TO BE DEVOTED ENTIRELY TO WAR PROBLEMS.

Only Matter of Major Importance to Be Presented—"Winning the War" Slogan of Association.

In a communication addressed to members of the National Electric Light Association, dated April 20, President J. W. Lieb makes the following comments relative to the forthcoming annual convention of the Association.

The thirty-fourth annual meeting of the National Electric Light Association and its forty-first convention, to be held at the Hotel Traymore, Atlantic City, June 13 and 14, 1918, will be devoted entirely to problems of the war.

This will be a strictly business meeting, without entertainment of any kind. It will concern itself entirely with the vital problems of the industry arising out of the war, toward the winning of which the thoughts and energies of every public utility must be consecrated.

No papers will be read. Reports from committees and individuals and discussions will be confined to matters of major importance and the brief two days will allow no time for the usual helpful discussions on general topics relating to the progress of the art. Everything said and done must be keyed to a victorious conclusion, and an early one, of the great struggle on which our nation has entered and in which our industry is taking a part of continually growing importance.

There will obviously be a reduced attendance far below the numbers in pre-war years. Naturally, member companies, large and small, will endeavor to be represented by at least one of their officers or executives; and others in attendance would preferably be selected from among those dealing directly with the member-company's activities affecting war work or civilian co-operation with the National Government.

Our industry, increasingly a permeating factor in the national life, is now subjected to abnormal strains on its personnel and resources. It is the desire at such a vital juncture to devote the time and energies of the Association and of those at the convention to only one enterprise which now counts—Winning the War.

EFFECTIVE GOVERNMENT CONTROL OF PETROLEUM PRODUCTS.

Mark L. Requa, director of the Oil Division of the United States Fuel Administration, speaking on the "War Service of the Petroleum Industry," says:

"If zonal distribution of petroleum products is necessary to supply national needs, zonal distribution will be accomplished. If pooling of tank cars and ships will more efficiently meet national demands, those facilities will be pooled. If well-drilling supplies must be allocated in order to produce the greatest quantity of oil to meet the increasing demands for oil, well-drilling supplies will be allocated. If licensing of jobbers and others is necessary, they will be licensed. If the petroleum industry or any part of it is so unwise as to engage in profiteering, ways and means will be found to correct that condition. In short, whatever the national needs may be, everything that is necessary will be done to meet those requirements. President Lincoln summed up the case when he said in 1863: 'I think the Constitution invests the Commander-in-Chief with the law of war in time of war.'"

UTILITY REPRESENTATIVES OF THE SOUTHWEST HOLD ANNUAL CONVENTION.

Discussion of War Problems Salient Feature of Three Days' Sessions at Galveston.

The consideration of problems relating to the prosecution of the war characterized the addresses and discussion at the fourteenth annual convention of the Southwestern Electrical and Gas Association held at Galveston, Texas, April 15, 16 and 17, 1918. The spirit that pervaded the convention was well reflected in the patriotic address by Edward F. Harris, Galveston, on "War Savings, a Solution of Our National Problem," who urged the vital importance of giving effective home support to the men on the firing line. He urged the electrical and gas men to encourage thrift among their employes and outlined the advantages of war savings stamps and certificates. Mr. Harris was frequently interrupted by applause.

Lynton T. Block, president of the Employers' Indemnity Insurance Association of St. Louis, spoke on "Jovian Insurance," telling of the advantages offered by the Jovian insurance plan, which is open only to members of the order.

H. C. Morris, president of the association, in his annual address, discussing the problems of public utilities, said: "The most vital matter is the ratio between operating expenses and gross income because that ratio must be in favor of the gross earnings to an extent to provide a reasonable return on our investment in our properties or we are potentially bankrupt, for the reason that one of our liabilities is the necessity of continually giving our customers a 100 per cent local service, and we are compelled to cut our service in either quantity or quality.

"The most surprising condition which has come upon many of us within the last year is that, while our gross receipts have largely increased, our operating expenses have increased in so much greater proportions that in almost every case our profits have decreased. As a matter of law we are compelled to take on any new business under prescribed conditions offered us in normal times, but the times are so abnormal that we are often compelled to protect customers by refusing new business which causes any expenditure for extensions, enlargements or increases.

"The question of fuel in Texas is a complicated

matter, because we have four fuels locally available—coal, lignite, natural gas and oil. The distances in the state are so great that freight and pipe line costs are a large factor. The necessities of the national government are such at this time that not only have the mine prices been raised on coal, but freight rates in some cases have also been advanced. It seems probable that the use of oil as fuel may be still further restricted in the future to an extent which will make it too costly or too uncertain for the use of public utilities."

At the second day's session reports were made by H. S. Cooper, secretary of the executive committee, during which he displayed a geological map of Texas, in which the locations of the lignite beds were shown. These beds were found to be located near the cities where the largest public utilities plants in the state are being operated. Mr. Cooper said that the deposits would be useless unless steps were taken to make the fuel easier to handle.

Upon suggestion of H. C. Morris, of Dallas, the committee agreed to consider sending two young men to the University of Texas to take a special course in geology to find a solution of the fuel problem through the lignite beds.

The question of increasing rates was discussed by nearly every one in attendance. The prevailing opinion was that eventually the rates must be raised because of the increased costs of labor and fuel. J. C. Kennedy, of Brenham, reported that some concerns have increased their rates without receiving complaints from the public. Others maintained that in nearly every instance the public probably would complain if the rates are increased, but that the public must be educated to the fact that it may be necessary to increase the rates on account of conditions being abnormal.

The question of obtaining sufficient labor during the war also was discussed. The delegates said that they were making the best of conditions under the circumstances, but all of the companies which they represent have lost many capable employes on account of the draft. Some of the companies are training men who are not subject to draft to take the places of men who have been called.

R. W. Van Valkenburgh, of Dalas, Texas, general manager of the Western Electric Company of Texas, read a paper on "Suggestions for Conservation in Purchasing from the Seller's Standpoint." The paper contained suggestions that might be used by the sellers and pointed out the necessity of conservation. The paper was followed by discussions on the subject.

The election of officers for the ensuing year resulted as follows:

President, W. A. Sullivan, Shreveport, vice-president and general manager of Shreveport Railway Company; first vice-president, Burr Martin, Dallas, general manager of Texas Electric Railway; second vice-president, E. S. Fletcher, general superintendent of Texas Power & Light Company, Dallas; third vice-president, A. Hardgrave, chief operating engineer of Southwestern Utilities Company; treasurer, J. B. Walker, Dallas; secretary of executive committee, H. S. Cooper, re-elected.

Members of executive committee are as follows: W. A. Sullivan, of Shreveport; Burr Martin, E. S. Fletcher, A. Hardgrave and H. C. Morris, of Dallas; R. Merriwether, of Dallas, general superintendent of the Dallas Railway Company; J. C. Kennedy, of Brenham, general manager of the Brenham Compress and Oil Company; S. R. Bertron, Jr., of Houston, vice-president and general manager of the Houston Light & Power Company; F. D. Murphy, of Houston, vice-president and general manager of the Houston Gas & Fuel Company; F. J. Storm, of Amarillo, vice-president of the Amarillo Gas Company; W. B. Head, of Dallas, vice-president of the Texas Light & Power Company; W. B. Tuttle, of San Antonio, vice-president and general manager of the San Antonio Public Utilities Company, and C. H. Clifford, of Dallas, representing the Northern Terminal & Texas Traction Company.

Members of Advisory Board: Alba H. Warren, manager of the Galveston Electric Company; H. O. Clark, of Houston; K. L. Simons, of El Paso; F. L. Weisser, of San Antonio; H. E. Danner, of Houston; B. F. Cherry, of Weatherford; A. Patterson, of Texarkana; D. G. Fisher and J. P. Griffin, of Dallas; F. H. Matthes, of Abilene; R. J. Irvine, of San Angelo; J. W. Carpenter, of Corsicana; H. E. Barton, of Calvert; J. E. Cowles, of Shreveport; F. M. Lawton, of Wichita Falls; P. A. Rogers, of Denison; V. W. Berry, of Fort Worth; R. G. Cooper, of Dallas; R. C. Jones, of San Antonio; R. W. Van Valkenburgh, C. W. Davis, H. E. Hobson and F. G. Kune, of Dallas, and C. A. Newning, of Houston.

COMMON SENSE FOUND VERY ESSENTIAL IN ILLUMINATION.

Paper by F. J. Pearson Before Illuminating Engineering Society Deals Chiefly With Store and Factory Lighting.

In spite of the important advances made in the art of illumination in the last ten years, it is not uncommon to find serious mistakes made in lighting installations. This emphasizes the imperative need for using common sense liberally in applying the principles of illuminating engineering to solution of any lighting problem. These were some of the most striking points brought out in a paper by Frederick J. Pearson before the Chicago Section of the Illuminating Engineering Society at its meeting on April 18. Mr. Pearson is electrical and mechanical engineer for Marshall Field & Company and spoke from an experience of some 15 years with this large mercantile organization, which owns the largest and finest retail store in America, besides a large wholesale house, about 20 textile and other producing mills, numerous warehouses, etc. Mr. Pearson's paper was entitled "Mistakes in Engineering as Applied to Illumination" and dealt especially with store and factory lighting.

Among such mistakes pointed out were: the use of an absolutely uniform lighting system throughout an establishment, instead of a fairly uniform general lighting system supplemented by such special lighting as is clearly necessary; failure to get the utmost out of factory lighting which is in use, as a rule, only 8 hours or less out of the 24 and therefore should be operated in an intensified manner to stimulate production, just as machinery is pushed to the highest speeds to increase factory output; giving too much attention to efficiency when sometimes a rather inefficient system will give better satisfaction and increased sales in certain departments of a large store, for instance; giving too much attention to purely technical considerations whereas many valuable common-sense opinions and suggestions can be obtained from department managers and even customers; copying of all the details of a lighting system, merely because it was satisfactory in a notable installation, without considering the conditions actually prevailing in the place where it is to be used.

Mr. Pearson said the choice of a lighting system must depend on the local conditions, such as (in a

store) the kind of goods sold, character of the customers, as well as size and finish of the rooms. The general lighting should provide good, uniform, general illumination with as uniform a type of unit as possible and this should be used on as many floors as possible to minimize maintenance costs. As large and as few units as possible should be used commensurate with the results desired, to keep down the initial and operating costs. However, these general considerations must not outweigh the requirements of the local conditions. The fixtures also should be of simple outline and in harmony with the surroundings. It is a good plan to use fairly dense diffusing globes with gas-filled tungsten lamps; an absorption of as high as 24 per cent in store lighting is not bad practice in view of the higher efficiency of such lamps and the elimination of glare thus produced. Drop cords should, and usually can, be almost entirely eliminated; they are troublesome and costly to maintain.

Show-case lighting is still unsatisfactory, chiefly on account of the poor service obtained from present candelabra lamps, Mr. Pearson said. In spite of the long agitation for better store-window lighting, there is room for much improvement, as many storekeepers still believe it is necessary to use numerous exposed lights that really kill the display. Factory owners are still about the worst parties to convince on the merits of good lighting; it seems to hurt them to speak on the subject. The result is that lighting conditions in most factories are abominable. There is no question as to the value of good factory lighting increasing the production very greatly. Likewise, in a store improved lighting increases sales. Mr. Pearson cited instances where an increase of the intensity from 6 to 10 foot-candles resulted in a very handsome profit, and where an increase of only 1 per cent in the cost of lighting increased the sales 6 to 7 per cent. In fact, improved lighting is one of the greatest dividend producers through its increase in the product, whether in the factory, store or office.

Discussion of the subject was participated in by E. H. Freeman, J. R. Cravath, L. C. Spake, O. L. Johnson, F. H. Bernhard, F. A. Watkins and Mr. Pearson. The latter said we are still very far from any real saturation point where increase in intensity and cost of artificial lighting will equal the increase in production or output, since we are still so far from actual daylight conditions.

AMERICAN ELECTRICAL GOODS IN AUSTRALIA.

American electrical goods, always well liked in Australia, have been in much greater demand there since the war started than ever before, according to a report published by the Bureau of Foreign and Domestic Commerce, Department of Commerce. No such extensive use is made of electricity as in the United States, but continuous propaganda and educational work will do wonders in the end. At present, Australians do not have the same desire to take up the quasiluxuries in electrical appliances that Americans of sufficient means will not do without.

General conditions and methods of conducting business in Australia are described by Commercial Agent R. A. Lundquist, who, however, devotes most of his space to detailed descriptions of the markets for particular lines of electrical goods, such as power-generating equipment, electric railway equipment, lamps, and domestic appliances. The report is entitled "Electrical Goods in Australia," Special Agents Series No. 155.

ENGINEERING COUNCIL'S GROWING ACTIVITIES.

New Water-Power Committee Formed—Public Questions Discussed in Bi-Monthly Meeting.

At the regular bi-monthly meeting of Engineering Council, April 18, many matters of common concern to engineers as well as some of public welfare, in which the profession is interested, were acted upon. There was a large attendance and representatives from several other bodies appeared before the Council. The procedure for the admission of additional societies to membership in Engineering Council was perfected and several societies were nominated; important new committees were created and statements of work done were received from committees previously appointed.

American Engineering Service Committee was engaged with its staff responding to requests from the War, Navy and other departments of the Government for men for special services along technical lines. Chairman George J. Foran of this committee reported that large number of names had been supplied through the co-operation of leading engineering and chemical societies. Special assistance is being given to the Ordnance Department in securing officers to expedite production; to the Navigation Bureau in finding men for the submarine service; to the Signal Corps in procuring special employes for aviation work, and to the Tank Corps in enlisting non-commissioned officers and mechanics. In connection with the last item, the Military Engineering Committee of New York has supplied engineering specialists to interview candidates in the rooms of the American Society of Mechanical Engineers and the American Society of Civil Engineers in the Engineering Societies Building let for the purpose. General arrangements for these interviews were made by Captain R. C. Stevens of the Army Tank Corps through the officers of Engineering Council.

The War Committee of Technical Societies, of which D. W. Brunton is chairman, has official connections with the War Department as well as with the Naval Consulting Board. It continues its function of culling the large numbers of new inventions and other suggestions constantly being received, selecting those which are worthy of investigation or development by the Navy or War or other departments. Manifestly, details of this Committee's work, being of a confidential nature, cannot be published.

On recommendation of the Public Affairs Committee, Charles Whiting Baker, chairman, a resolution was passed urging authorities of engineering schools of the country to direct all their resources to the winning of the war in such ways as relieving from routine duties, so far as practicable, teachers engaged in work for the Government or upon other war work and allowing such teachers the assistance of undergraduate students; by crediting such students for this work, if it can properly be done, by relieving them of prescribed work in their courses of less importance; by offering shops and laboratories for the solution of war problems and by training undergraduates in the fundamentals of engineering even at the sacrifice of some specialization on subjects not connected with the war. The secretary was directed to send copies of this resolution to the technical colleges.

Prof. L. P. Breckinridge, chairman of the Fuel Conservation Committee, reported that matters of importance had been considered for the Fuel Administration and for the Bureau of Mines.

In order to follow up the good work in connection with water-power legislation, begun by Engineering

Council and to be prepared for effective action upon other questions arising in the broad field of utilization and conservation of water for municipal supply, power development, irrigation, sewage disposal and navigation, a new committee was created to be known as the Water Conservation Committee.

Matters concerning the welfare of engineers in the war services of the Government, have received hardly more than accidental attention from the engineering societies, and in some instances none at all, because of the lack of a suitable organization to deal with them. To meet these needs in a broad way, Engineering Council authorized the appointing of a Military Aid Committee to deal with activities ranging from supplying the needs of some engineering units in training camp, or in combatant service, to assisting the Government authorities in recruiting special engineering units or utilizing military engineering units on public works after the war.

The oft recurring question of licensing or registering engineers under state laws was raised by one of the representatives on the Council and by a reference from the American Society of Civil Engineers. This matter was referred to the Public Affairs Committee for study and the organizing of a special sub-committee to deal with the subject actively.

Chairman J. Parke Channing of Engineering Council announced that the following well-known engineers had accepted appointment on the Patents Committee, created by the Council at its February meeting: Chas. A. Terry, chairman; C. A. P. Turner, Corydon T. Purdy, J. Parke Channing, Horace V. Winchell, Edwin J. Prindle, D. S. Jacobus, Frank N. Waterman. This committee will investigate reforms in the United States patent system and in the use of experts in litigation wherein validity of patents or other technical matters are involved, co-operating with similar committees of the National Research Council and other technical societies.

By invitation, President F. P. Fish of the National Industrial Conference Board presented personally to Engineering Council resolutions adopted by the Board at meetings being held in New York City. These resolutions requested Engineering Council, as the representative of the great engineering societies of the United States, to investigate and publicly express itself as to whether or not the nation is gaining or losing in industrial efficiency and what causes, if any, are influencing the condition, and in what manner, broadly it is believed, industrial efficiency can be further stimulated. These resolutions also urged opposition to proposals under consideration in Congress in connection with appropriation bills to prohibit, diminish, and condemn the payment to public employes, or employes of private establishments under Government control, of any cash reward premium or bonus for superior services. Mr. Fish was accompanied by James A. Emery, of the War Labor Board, who presented strong arguments in support of the resolutions. By vote of Engineering Council, the chairman appointed as a special committee to give this matter immediate attention, Prof. George F. Swain, chairman, E. W. Rice, Jr., Chas. T. Main, Alexander C. Humphrey and Benjamin B. Thayer, all of whom are men well informed upon large industrial affairs.

At the request of the War Committee of Technical Societies, an officer who had had extensive experience on the western front explained to the Council the importance of having a suitable proportion of engineers, superintendents and foremen who had had practical experience in construction work, properly distributed among the fighting troops, in addition to those already connected with the engineering and labor regiments.

The relationship of Engineering Council to local societies and to the local sections or association of the National Societies received extensive consideration and will come up for action at a later meeting of the Council.

ILLUMINATING ENGINEERING SOCIETY ACTIVE IN WAR SERVICE.

The Illuminating Engineering Society with headquarters in the Engineering Societies Building, New York City, has issued a folder summarizing the society's endeavors to aid in prosecution of the war.

As soon as war was declared, the society offered its services to the Government. Since then it has lost no opportunity to be of service. Its Committee on War Service, acting upon requests received directly or through the National Committee on Gas and Electric Service, has designed lighting installations for various departments of the Government. The committee has also prepared a treatise on protective lighting at the request of government officials.

Members nominated by the society consulting the Divisional Committee on Lighting under the Committee on Labor, of the Council of National Defense, have prepared a treatise on industrial lighting for application wherever work is done under contract with the Government. Lighting experts for each state in the Union have been selected to co-operate.

The National Research Council has availed itself of the services of the society's experts in prosecuting its researches on problems involving lighting and vision.

The society's membership has been classified so that the Government may have ready access to lighting specialists.

Dues have been remitted to members who have entered military service.

These activities are making large demands on the society's resources; more members are therefore needed if its service to the Government is not to be impeded. Application for membership, together with a statement of the society's purposes and activities can be had on application to the secretary at the above address.

GENERAL ELECTRIC EMPLOYEES SHOW PATRIOTISM BY BOND SUBSCRIPTIONS.

In one of the largest and most spectacular parades ever seen in Schenectady 23,000 employees of the General Electric Company marched through the city Saturday noon after finishing a Liberty Loan campaign that sold more than a million and a half dollars worth of bonds. With hundreds of floats, countless flags and banners, accompanied by mounted marshals and 20 large bands, the General Electric parade marched for miles through the city, stopping only long enough to assist at the unfurling of the city's quota flag on State Street.

The Liberty Loan figures for the Schenectady plant at noon, Saturday, April 20, and still growing, were as follows:

Subscriptions	$1,550,150
Number of subscribers	21,835
Total number employees	22,627
Percentage subscriptions	96.5
Average number subscriptions	71
Average per employee	68.50

WISCONSIN ELECTRICAL CONTRACTORS HOLD ENTHUSIASTIC MEETING.

Discuss Trade Acceptances, Industrial Lighting, Merchandising and Overhead at Madison Convention.

The quarterly meeting of the Wisconsin State Association of Electrical Contractors and Dealers, held in Madison on April 23 and 24, was characterized by a good attendance, able addresses and papers, and the keenest of interest on the part of all present, as was evidenced by the ready and general discussion of the numerous subjects considered at the convention. The success of the meeting was of itself a potent argument as to the good results of thorough organization work. The influence of 100 active members in the association of this state was apparent in the atmosphere created by the gathering, although the entire membership may not have been present. It was announced that Wisconsin's association, in respect to the number of members and the effectiveness in the industry, was exceeded by that of one state only, and that was Massachusetts. A reason for the association's vitality was seen in the activity and enthusiasm of its officers, executive committee and other leading members.

The features of first day's session were the brief but pointed address by R. J. Nickles, state chairman, of Madison; the report of John A. Piepkorn, state secretary, of Milwaukee, and the address on "Trade Acceptance" by B. V. Dela Hunt, cashier of Merchants' and Manufacturers' Bank, Milwaukee.

Mr. Nickles spoke especially of the progress made by an association committee in conferences with a jobbers' committee in the matter of securing a preferential price on merchandise handled by electrical merchants. He anticipated being able to report more definitely at a later meeting.

Mr Piepkorn's report on the growth, objects, problems and scope of the association was thorough and lucid. He asked for special co-operation in developing a cost-keeping system adaptable to electrical contractors and dealers.

W. R. Johnson, Wausau, treasurer of the association, reported the condition of its finances and spoke with enthusiasm of the co-operative work developed by the Wisconsin association.

Mr. Dela Hunt's treatment of the subject of "Trade Acceptances" was characterized by clearness and brevity of expression from the standpoint of the banker, who looks upon them as a means of enlarging commercial credits, based upon tangible business transactions. He pictured this system as one that would furnish a continuous stream of negotiable, liquid assets from the ultimate consumer of commodities up to national reserve bank; as one that makes possible a much larger volume of business with the same capital as now figures in business on the book account basis. It establishes a distinct class of commercial paper based upon the transfer of goods. In this country $4,000,000,000 was constantly tied up in open book accounts, unavailable as credit. He described the practical operations of the trade acceptance and showed how it would transform the storekeeper into a real merchant, training him to take care of his obligations and protect his credit. The United States needs this system now to meet the existing crisis. He exhibited numerous forms of trade acceptance.

The discussion which followed showed how greatly interested the members were in the subject. While there was some expression of skepticism as to its effectiveness, the force of the convention was favorable to the trade acceptance plan. The facts as to its adaptability to the retail trade, involving small amounts, were brought out. Some interesting points came to the surface in the discussion as to its use in connection with sales on the installment plan.

The Banquet.

The banquet at Park Hotel was attended by all members, Chairman Nickles acting as toastmaster, who said the keynote of the organization was co-operation between contractor, dealer, jobber and central station. This co-operation, he said, was essential to back up the Government in the war.

Bert Williams, internal revenue collector, who was introduced, delivered an eloquent and stirring address on the issues of the world war and appealed to all at home to give unstinted support to our boys on the firing line, to see that they do not lack food, ammunition and supplies.

At the close of the banquet the members became a theater party at one of Madison's playhouses.

Wednesday's Sessions.

Wednesday's sessions were replete with matters of vital concern to contractors and dealers. John L. Acker, president of Acker Electrical Company, Sheboygan, explained "Why the Electrical Contractor Should Become a Merchandiser." The reasons he gave were those dug up from a quarter-century of experience, for Mr. Acker began when the electrical industry was young.

R. B. Snyder, general sales manager of T. M. E. R. & L. Co., Milwaukee, elucidated the subject of "Selling Merchandise on the Installment Plan," and led the discussion that followed.

Paul C. Burrill, secretary of Herman Andrae Electrical Company, Milwaukee, presented a paper on "Overhead Expenses in Our Business," which interested all and elicited considerable discussion.

"Industrial Lighting" was handled by John Hoeveler, Industrial Commission of Wisconsin, Madison.

A more complete report of the second day's sessions will be published in our next issue. The hour following luncheon on Wednesday was devoted to "Viewing Madison by Auto," which was arranged for by the contractor-dealers of Madison.

BOSTON CONTRACTORS DISCUSS TRADE ACCEPTANCES.

On Thursday, April 18, there was a meeting of the Boston District of the Massachusetts State Association of Electrical Contractors and Dealers at the Engineers' Club, Commonwealth Avenue, Boston.

The meeting was attended by 40 people, including jobbers, manufacturers and contractor-dealers.

M. A. Curran, general credit manager of the Western Electric Company of New York, addressed the meeting on "Trade Acceptances." After his remarks, a general discussion among the members lasting two hours was indulged in, and Mr. Curran was asked many pointed questions, all of which he replied to in a masterly manner.

At the close of the meeting it was the opinion of many that trade acceptance is a matter for the serious consideration of all, particularly the contractors in their dealings with manufacturers and jobbers. Many facts that apparently were misunderstood by some who were present were satisfactorily explained by Mr. Curran, and in a meeting lasting from 4 p. m. until 9 o'clock, the 40 present unanimously declared that the meeting was one of the most successful held by the Boston District of the Massachusetts Association.

NEED FOR WATER-POWER DEVELOPMENT SHOWN.

Situation in California Similar to That in Many States Having Undeveloped Resources.

By Frederick S. Myrtle,

Publicity Manager, Pacific Gas & Electric Company, San Francisco, Cal.

The necessity for hydroelectric power development in California in order to cope not only with existing conditions, but with conditions that are likely to arise in the future, is well understood. This power development, it must be understood, must be unhampered by grinding laws and mischievous restrictions. There must be a radical departure from the "Heads we win, tails you lose" policy that appears to be favored by those legislators whose ideas of progress are clouded by fear lest business enterprise bring reward in dollars. Otherwise, the much-needed development cannot be accomplished.

So much mischief has been done through the agency of the political agitator and would-be reformer that the public judgment upon such matters has been, to a great extent, thrown out of balance. Erroneous impressions resulting from the lack of correct information and the expression of unsound views by well-intentioned but mistaken publicists are not easily eradicated; consequently, at a time of stress such as this, when the country demands the most complete development of its available resources, the path of progress is strewn with obstacles that have been slowly but surely growing out of the ground, as it were, for generations.

The San Francisco *Chronicle* had an editorial on this subject recently. Some of the statements it contained must have come upon many of its readers with a shock of surprise. To quote: "It depends on circumstances whether there is any profit to individual investors in the development of hydroelectric power. In support of this statement the newspaper published an excerpt from the report of the committee of the United States Chamber of Commerce, appointed to investigate the subject. The following condensed statement was given:

"There is a very general, but entirely erroneous, belief that any water power running to waste can be utilized at small expense. The initial cost of a steam plant is in general but one-half to one-fifth that of a water-power plant of equal capacity. Moreover, because a steam plant can be more easily enlarged from time to time, the initial development of a water-power plant must, in general, be a much larger proportion of the ultimate contemplated development than in the case of a steam plant. It follows that an investor in a water-power plant is burdened from the very start with a heavy fixed charge, the failure to meet which may mean bankruptcy. The risks to capital in water-power developments are, therefore, much greater than the risks in the case of steam power. The advantage of water power lies in its smaller expense of maintenance, due to the smaller amount of labor and the absence of any cost for fuel.

"Water power will not be developed unless conditions are made comparatively favorable. Present demand for the development of such power comes, not from the capitalists, but from the communities, which, on account of the high price and scarcity of fuel, are desirous, in their own interests, of inducing capital to make such developments."

"Whatever happens to individuals, however," observed the *Chronicle*, "to society there is profit in every kilowatt produced, by reason of its saving so much fuel. Obviously, therefore, the proper public policy lies in extremely liberal inducements to investors willing to take chances in order that the greatest possible development of hydroelectric power may take place. What Congress has done under the influence of impractical theorists, who assume that the development of hydroelectric power means wealth to developers, is to put an end to such development on the public domain by imposing impossible conditions."

It is a matter of common understanding that no part of this country is more deeply concerned in hydroelectric development than California. So long as California was dependent on coal for power, she found it impossible to compete with the eastern industrial field. The discovery of oil came to the rescue, but a situation has arisen to meet which this fuel must be conserved in every possible way. It remains, then to let the California mountains solve the problem, to let water take the place of coal and oil. Unfortunately, the restrictions imposed by Congress upon hydroelectric development on the public domain have had the effect of causing private investors to throw up their hands. They do not seek the privilege of development under the conditions imposed.

Considerations Involved in Problem.

The interest of the public lies in granting permanent ownership of their property and operating rights to those public utilities which supply permanent needs, in order that there may be a guarantee of the best available service, in the first place, and, in the second place, of its continuity, with the assurance of all such additions and betterments in construction and distribution as the conditions of constantly growing communities call for. Without such permanent ownership, the public utility resolves itself into a more or less speculative enterprise, the owners of which feel compelled to get all they can out of it in the way of profit during the life of such franchises or licenses as may have been granted them, leaving the problems involved in the period approaching their expiration to be dealt with by future generations.

In all public utilities that serve permanent needs there must be ownership in perpetuity, either in terms or in effect, in order that the service may be perpetual. In such legislation, therefore, as is now being debated in Congress, due recognition should be given this necessity. In order that the public may be served most economically, the public utility must be allowed some guarantee of a regular and uninterrupted run of business, its operations unhampered by fear of what may happen at the expiration of a given period. Where the utility is compelled, for instance, to provide an amortization fund large enough to take care of the investment, or a considerable portion thereof, in the event that its business may be taken away from it at the expiration of such permit or franchise as that under which it is operated, the public, as the consumer, must be the loser, as it will be impossible for the utility to give this service at rates such as might be enjoyed under conditions of permanent ownership.

It is to the interest of the public that the utility serving it be granted such a tenure of property and operating rights as will allow its owners and operators full protection of their investment as well as enable them to earn reasonable interest return thereupon, and not compel them to look to extra profits during a fixed period to enable them to provide against an anticipated termination of their rights of ownership, accompanied by less than full compensation for their property and business representing their investment.

Commercial

High Efficiencies of Electric Pumps—Brooklyn Edison Co-operates in Bond Campaign—Range Performance Records

HIGH EFFICIENCIES OF MOTOR-DRIVEN WATER-WORKS PUMPS.

Tests of Two Electric Pumps at McCarren Pumping Station in St. Paul.

Many pumping problems are most conveniently solved by electrically driven pumps. Such pumps constitute a peculiarly desirable load for central stations, as they operate either at full load continuously or in some cases only during periods of light load, thus helping to fill up the valleys in the load curve.

Where centrifugal pumps are operated by power purchased through a meter, careful attention is likely to be given to efficiency, as a few per cent in efficiency will in a short time amount to more than the cost of the pumps. The figures showing efficiency and other characteristics of two 12-inch motor-driven centrifugal pumps herein given are taken from a report made by J. W. Kelsey, principal assistant engineer to G. O. House, general superintendent of the St. Paul Water Department, and relate to equipment recently installed at the McCarren Pumping Station.

DESCRIPTION OF EQUIPMENT.

The specifications required that each unit should be guaranteed to deliver not less than 5000 gallons per minute against a total head of 171 feet, and not more than 5500 gallons per minute against a total head of 158 feet, the over-all efficiency from "wire to water" to be not less than 72 per cent when pumping continuously at either of the heads and deliveries. It was further required that when delivering against a reduced head of 140 feet the motor should not be overloaded.

The bid of the Northwestern Electric Equipment Company of St. Paul, Minn., which was accepted, offered pumps manufactured by the De Laval Steam Turbine Company, of Trenton, N. J., and synchronous motors of the rotating-field type, manufactured by the Electric Machinery Company, of Minneapolis, and guaranteed an efficiency of 74.3 per cent at heads of either 158 or 171 feet, and an over-all efficiency of 73.7 per cent at 140 feet.

The motors receive three-phase, 60-cycle current at approximately 2200 volts and drive the pumps at 1200 revolutions per minute. They are so designed that they can be started by the application of alternating current to the armature windings. In normal operation they are supplied with exciting current by direct-connected exciters of 1¾ kilowatts capacity.

The pumps are of the De Laval single-stage double-suction volute type, having 12-inch suction and discharge nozzles. No diffusing vanes are used.

After installation, both units were subjected to very complete tests to determine both efficiency and head-capacity characteristics. Before the official tests were run the impellers had been turned down slightly in diameter, due to the fact that the motors were operating at 20 revolutions per minute above rated speed.

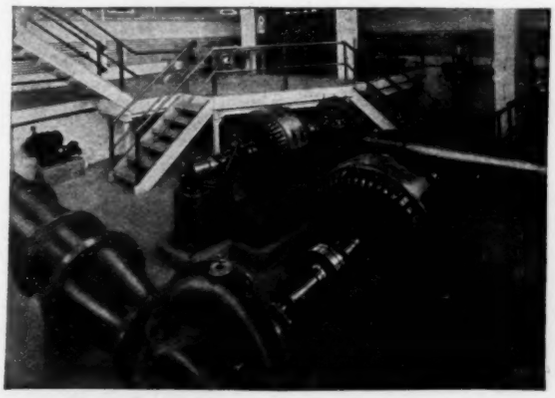
TEST OF PUMPING SETS.

Before beginning the test, the pressure gauge of each pump was taken off and calibrated on a dead-weight testing instrument and then replaced, the pump stopped and the static head of water determined by finding the elevation of the center of the gauges and the elevation of the water in the high-service reservoir. The head determined from the elevations was found to agree with the calibration obtained with the dead-weight testing instrument. The readings of the suction gauges were also checked against elevations in a similar manner and found to be correct. As they registered zero with no pressure and as the variation in head was never more than 10 feet, it was assumed that readings of the gauges between zero and 10 feet would be proportional.

The quantity of water delivered was measured by a 30 by 13-inch Venturi meter, supplied by the Builders Iron Foundry Company, of Providence, R. I. The recording instrument supplied with this meter includes an indicating dial, a recording card and an integrating counter, but in order to verify the accuracy of its readings, an indicating mercury manometer was also connected to the pressure pipes of the Venturi tube.

The electrical measuring instruments were checked and calibrated subsequently, by comparison with standard instruments, by representatives of the Northern States Power Company.

In running the test, the head against which the pumps worked was controlled by means of a hydraulic gate valve on the discharge side of the pumps. After



Motor-Driven Centrifugal Pumps in McCarren Pumping Station, St. Paul, Minn.

throttling the gate valve, no readings were taken until all instruments had ceased fluctuating, after which two or three readings were made and averaged, if any variations were found. Observations were made with the pumps operating under four different heads, covering a wide range of delivery.

The results obtained on the official test are shown in the tabulation given below. In computing the efficiencies of the pumps alone, motor efficiencies, as ob-

DATA ON TESTS OF PUMPS.

	Motor No. 403115—Pump No. 25650.				Motor No. 403129—Pump No. 25651.			
Voltmeter	2230	2230	2240	2240	2250	2260	2270	2295
Rec. watt-hour meter	234.0	225.0	210.0	165.0	224	217.4	204.8	188.1
A. C. ammeter	62	59.5	55.5	44.5	57.6	56	52.4	47.8
P. F. indicator, per cent	100	100	100	100	100	100	100	100
Ind. wattmeter	233.3	226.2	210.1	165.3	226.3	220.2	206.0	188.9
Vent. manometer	9.75	8.50	7.25	4.60	9.4	8.24	7.1	5.9
Pressure gauge, ft.	147.25	165.25	179.25	195.75	146.5	163.0	176.5	186.0
Suc. gauge, ft.	4.0	6.0	7.5	10.0	3.2	5.0	6.5	8.0
Total head, feet	143.25	159.25	171.75	185.75	143.3	158.0	170.0	178.0
Revolutions per minute	1220	1220	1220	1220	1220	1220	1220	1220
Gallons per minute	6771	5900	5035	3194	6527	5722	4930	4097
Water H. P.	245.1	237.5	218.4	150.0	236.4	228.7	211.9	184.3
Electrical H. P.	312.9	303.3	282	221.7	303.4	295.2	276.1	253.1
Over-all efficiency	78.4	78.3	77.7	67.7	78.0	77.5	76.4	72.8
Brake H. P.	298.5	289.6	269	209.9	289.0	280.8	262.2	239.3
Pump Efficiency	82.2	82.1	81.2	71.5	81.8	81.5	80.7	77.0

tained on tests of the motors by the University of Minnesota, were used.

On motor No. 403,115 the following efficiencies were obtained:

Full load, 95.5 per cent; ¾ load, 94.9 per cent; ½ load, 93 per cent.

Motor No. 403,129 gave the following results:

Full load, 95.3 per cent; ¾ load, 94.6 per cent; ½ load, 92.5 per cent.

The test results of the units show the variations in head and capacity at constant speed, together with electrical horsepower input and over-all efficiencies.

The efficiencies obtained on these pumps are quite high, considering the comparatively small capacity and the high head. Many builders would advocate the use of diffusing vanes for such conditions, which, however would make the pump more expensive and complicated without any gain in efficiency. The efficiencies are further very high over a considerable range in capacity. Take for instance, pump No. 25,651, which at a capacity of 6527 gallons per minute shows an efficiency of 81.8 per cent and at 4097 gallons per minute an efficiency of 77 per cent, or for a reduction in capacity of about 37 per cent there is a reduction in efficiency of only 5.9 per cent, which must be considered very good for a centrifugal pump.

The pumps deliver slightly more than 5500 gallons per minute at 158 feet total head, but this was not at all objectionable, due to the fact that the efficiency was very high also at low heads, which in this particular case was of great advantage, as can be seen from following quotation from the official report:

"As to the quantity of water pumped, it will be observed that it more than meets the requirements of our specifications. The clause in our specifications limiting the quantity of water to 5500 gallons per minute when working against a head of 158 feet was inserted to insure a high efficiency at this pressure. It was our belief that the maximum efficiency would be obtained when pumps were working against a much higher head. Fortunately, however, the reverse is true and our pumps are delivering a greater quantity of water with a higher efficiency than was anticipated at the lower heads.

"As stated before, the friction loss in our force mains is less than computed, with the result that our operating head is somewhat lower than provided in our plans, which explains one of the main reasons for reducing the effective diameter of the impellers. The consequence is a greater quantity of water at a higher efficiency against our prevailing dynamic heads."

Canada to Build Steel-Ship Yards.—The Minister of Naval Affairs, Canada, according to reports from Ottawa, has announced that the Dominion Government is planning the construction of large steel ships in the Maritime Provinces. This plan contemplates an arrangement with the Dominion Iron & Steel Company, Sydney, Nova Scotia, for the building of a steel plate rolling mill, estimated to cost $5,000,000.

EXAMPLE OF GREATER PUBLIC SERVICE FROM UTILITIES.

The tremendous demands upon the public utility companies caused by the war are illustrated by the experience of Northern States Power Company in 1917. This company, under the management of H. M. Byllesby & Company, serves Minneapolis, St. Paul and a large number of other cities in the central northwest, none of which was engaged in munitions production to a large extent. Eighty-seven per cent of the gross earnings and 95 per cent of the net earnings of this company are derived from the sale of electrical energy. In 1917 the company was called upon to supply 306,714,706 kilowatt-hours, or 27 per cent more electricity from its water power and steam sources than in 1916. Although a considerable number of small communities were added to the lines during the year, the great bulk of this unprecedented increase in demand came from factories, flour mills and other diversified industries requiring power. At the close of 1916 the company served a total of 102,247 horsepower in motors. During the succeeding 12 months additional power business connected to the lines aggregated 25,442 horsepower, an increase of nearly one-fourth. Early in 1918 the company had under contract and about to be connected 21,200 horsepower, which added to that gained in 1917 totals 46,642, a gain equivalent to 45 per cent of the total power business served only 15 months before.

During 1917 the demand for service from municipalities formerly supplied by small isolated plants, or lacking service, continued, with the result that 64 communities were joined to the 139 previously supplied, making a total at the close of the year of 203, with an estimated population of 951,200. Upwards of 300 miles of new electrical transmission system were constructed.

NEW BUSINESS GAINS AT MINNEAPOLIS.

The Minneapolis General Electric Company, Minneapolis, Minn., during the week ended March 30, accepted 534 electric contracts, covering 322 kilowatts of lighting and 319 horsepower in motors. Orders were taken for wiring 38 houses already built. Following the rescinding of the light conservation order in Minneapodis, seven mercantile establishments contracted for electric signs containing a total of 1620 five-watt lamps. The connected load gain for the week included 62 customers with 143 kilowatts of lighting and 1042 horsepower in motors, of which 905 horsepower is for the Twin City Trading Company.

UTILITY COMPANY DEVOTES SALES FORCE TO SALE OF LIBERTY BONDS.

Edison Electric Illuminating Company Promptly Does Its Part in War Crisis.

The prompt and effective response of the public utilities generally in meeting the Government's require-

Brooklyn Daily Eagle-4/14/18

To Brooklyn Edison Customers

"With our backs to the wall, and believing in the justice of our cause, each one of us must fight to the end."

Field Marshal Haig's order of yesterday to the British Army applies to us all. It is now or never!

To do our part in the fight, beginning tomorrow morning, our entire selling force will join in the Third Liberty Loan Campaign, and will make a complete canvass of all Edison Customers.

It is a work devoid of all compensation, except that which comes from the satisfaction of doing one's duty in this World Crisis.

We know Edison Customers will appreciate the spirit under which this work is undertaken, and we bespeak for our salesmen's call that reception which is best measured by results obtained.

EDISON ELECTRIC ILLUMINATING CO. OF BROOKLYN

Advertisement Announcing Co-operation of Brooklyn in Liberty Bond Campaign.

ment for the Third Liberty Loan is well illustrated by the action taken by the Edison Electric Illuminating Company, Brooklyn, N. Y., when on April 13 the general sales agent, T. I. Jones, called his entire sales force together and outlined the part the Edison company was to play in the Liberty Loan campaign, and directed that each man on his sales force devote four hours per hay to the sale of Liberty Bonds. Every salesman present himself subscribed for a bond of at least $50, and some went as high as $1000.

The Liberty Loan campaign opened April 15, and on April 14 the company ran an advertisement in all the Brooklyn newspapers, announcing its Liberty Loan plans, which is reproduced herewith.

The result of the first day's campaign was that the company's salesmen turned in 121 bond subscriptions, which amounted to $9350. The results of the second day were 119 subscriptions, aggregating $8850.

MEETING OF OHIO INDUSTRIAL POWER AND HEATING SECTION AT CLEVELAND, MAY 8.

Electric Furnaces and Other Commercial Problems to Be Discussed by Committee of Ohio Electric Light Association.

A meeting of the Industrial Power and Heating Section of the Ohio Electric Light Association will be held May 8, 1918, at the Hotel Statler, Cleveland, Ohio, under the guidance of the New Business Co-operations Committee of the Association. The program, as prepared by the committee, is as follows, the session to begin at 9:45 a. m.:

Address of welcome by M. E. Turner, assistant general manager, the Cleveland Electric Illuminating Company.

"The Present Status of the Electric Brass Furnace," by H. M. St. John, research engineer, Commonwealth Edison Company, Chicago. Discussion by E. F. Collins, manager industrial heating engineering department, General Electric Company, Schenectady, N. Y.; and by T. F. Baily, president Electric Furnace Company, Alliance, Ohio.

A brief period prior to luncheon is reserved for informal discussion and for answering questions.

Rev. Dean H. P. Almon Abbott, Cleveland, is announced for an address during the luncheon hour.

At the afternoon session the following papers will be presented:

"Silent-Chain Drives Used in the Application of Electric Motors," Paul V. Wheeler, engineer, drive chain department, Link-Belt Company, Cleveland.

"War-Time Economies," W. A. Wolls, new business manager, Columbus Railway & Light Company.

F. B. Steele, of the Dayton Power & Light Company, is chairman of the section.

KEEPING RECORDS OF ELECTRIC-RANGE PERFORMANCE.

Although the inherent advantages of the electric range have a particular appeal under present conditions, there are still many potential customers who are somewhat skeptical regarding operating costs.

The Rockford (Ill.) Electric Company, early in its range activities, came to the conclusion that it was necessary to keep accurate operating records for every range customer and thus fortify itself with actual data regarding the monthly cost. The accompanying record has been used with considerable success by the company.

The keeping of these data has the added advan-

Rockford Electric Company

CUSTOMER'S RANGE RECORD

Folio ..... Route No. .....

Name ..... Address .....

Type ..... Range Sale No. .....

Date installed ..... No. in family ..... Servant? .....

Selling Price, $ ..... Cost of installation, $ .....

Rate Data: .....

.....

Meter No. ..... Cooking Only / Cooking and Lighting

Remarks: .....

.....

.....

	1917			1918			1919			REMARKS
Month	K. W. Hrs.		Net Bill	K.W.Hrs.		Net Bill	K.W.Hrs.		Net Bill	
Jan.										
Feb.										
Mar.										
Apr.										
May										
June										
July										
Aug.										
Sept.										
Oct.										
Nov.										
Dec.										
Aver.										

Record Used to Keep Data on Range Performance.

tage of checking the performance of each range, thereby insuring good service to the users. Excessive consumption either indicates trouble or unintelligent use of the equipment and can be remedied before the customer becomes unnecessarily prejudiced against electric cooking.

Operating

Outdoor Substation Cost Data—Automatic Re-closing Oil Switch for Automatic Substations — Operating Notes

STEEL TOWER OUTDOOR SUBSTATION FOR INDUSTRIAL LOADS.

Cost Data of Typical Outdoor Station of 450 Kilovolt-Amperes.

The recent coal shortage has given great impetus to the sale of high tension power to those who formerly operated isolated plants. This is especially true in manufacturing centers where factory owners are extremely anxious to secure a reliable power source.

The outdoor substation has proven a highly satisfactory medium of supplying such consumers as it can be quickly erected, has a low cost per kilovolt-ampere, and should conditions change, the equipment can be used at other points on the transmission lines.

The past year has witnessed serious attempts to standardize equipment having a minimum amount of steel structure and yet of substantial construction. Among the types developed those employing standard steel frames have met with success. A typical design is illustrated, a schematic diagram of which is also shown to the right.

This installation is designed for connection to either or both of two parallel and synchronous lines as the electrical connections indicate.

The load switches are of the double break per phase type provided with interlocked mechanisms having operating handles at ground level. Fuse protection is provided for the transformers, thus eliminating the expensive oil circuit breaker. The lightning arresters are provided with a limit fuse, a practice growing in favor and are of the horn type with graded resistance in the ground circuit.

The following bill of material and cost data show that the low cost per kilovolt-ampere makes this type an attractive proposition in selling high tension power:

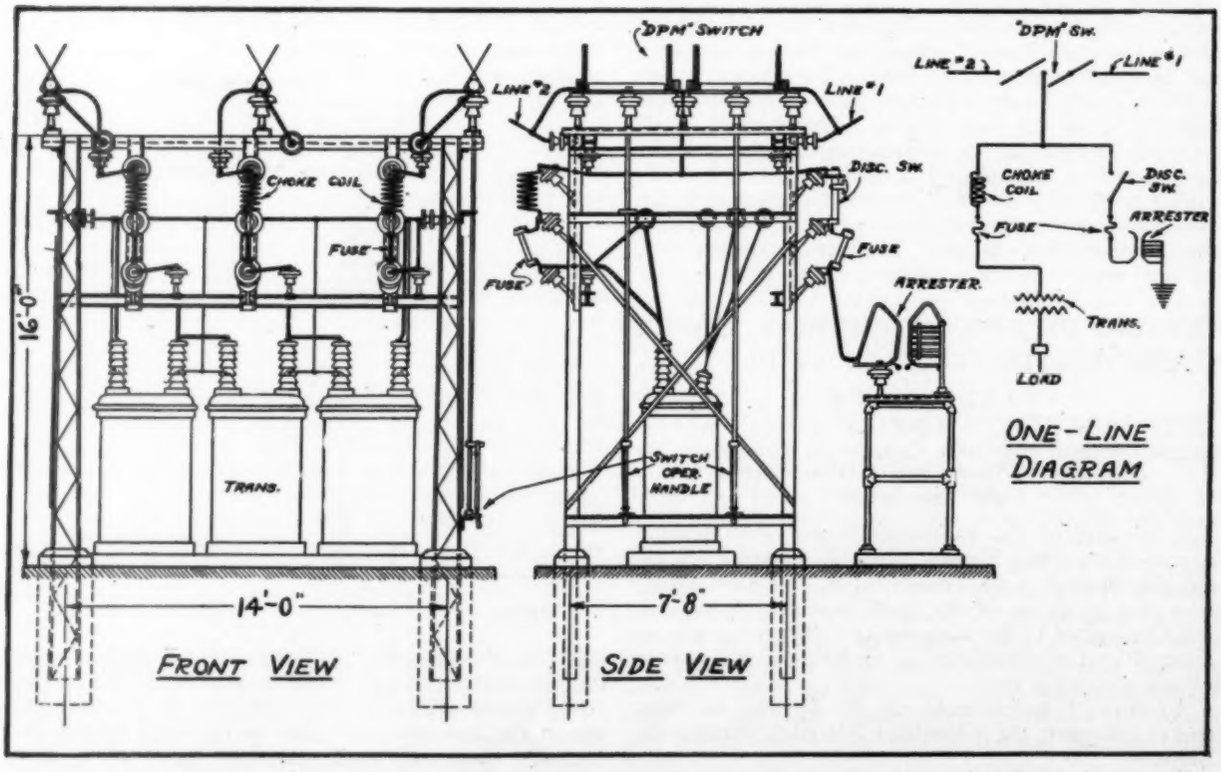
TWO-CIRCUIT 22,000-VOLT 3-PHASE 450-KILOVOLT-AMPERE STEEL-TOWER SUBSTATION ....

MATERIAL LIST.

3 150-kilovolt-ampere G. E. transformers.
1 Expanded steel tower.
1 Delta-Star Electric Company "DPM" 3-pole double-switch.
3 Delta-Star Electric Company combination choke coil and fuse units.
3 Delta-Star Electric Company disconnecting switches and fuses.
3 S&C graded resistance lightning arresters.
1 Interlocked switch operating mechanism.
6 O. B. petticoat insulators.
24 O. B. disc strain insulators.

Total cost of material	$4050.00
Cost per kilovolt-ampere complete	$ 9.00

Above prices are based on present costs and insulators rated at 33,000-volt normal for test voltage 125,000 volts.



General Arrangement and Scheme of Connections for Two-Circuit Steel-Tower Outdoor Substation.

TEST METHODS FOR SERIES CIRCUITS.

Simple Method of Locating Opens, Grounds and a Daylight Test on Series Circuits.

By W. I. Carpenter,

City Electrician, Modesto, Cal.

The following method will, the writer believes, be found more simple, quicker and safer for locating opens or grounds than the one offered by E. N. Vickery on page 606 in the April 6 issue of the Electrical Review.

For many years the writer has located open-circuits in series tungsten lighting circuits by grounding both sides of a series circuit at the switchboard with power off. Then by going to the middle of the circuit, lowering and removing the lamp and inserting a plug with circuit on one side only (this refers to incandescent lighting with film cutouts) a magneto is connected. The other side of magneto is connected to ground by means of a large spike driven in the ground. If a ring is obtained all is clear back to switchboard on this side. Now reverse the plug and if no ring is received you have located it and know that the open-circuit is in this half of the circuit. The next thing is to go back half way along the half of the circuit in trouble and repeat again the above procedure. This will locate the "open" after a few more tests and in a hurry. If no ring is obtained each way it indicates there are two opens, in which case it is necessary to start from one end and work out until the first open has been located, then proceed as before.

To locate grounds the writer has found the following satisfactory: Leave the station ends both open and work out along the circuit with the magneto until no ring is obtained in the direction in which the circuit is being patrolled (work on one side only). As soon as the ground has been passed an open exists and it is then necessary to back up until the exact location of the ground is found.

A simple daylight test may be accomplished in this way. Fix up a test plug with 110 volts, place a lamp in series and leave connected in series with the street lighting circuit during the day. In this way a test that is sure and on the job all the time is obtained as the light will go out when the circuit opens. These tests can be applied to any series circuits and yet can be made simply and cheaply with materials on hand.

A CAUSE OF METERS HUMMING.

By W. F. Hankins.

The article entitled "Causes of Meters Humming and Their Remedies," which appears on page 564 of March 30 issue of Electrical Review, is both interesting and instructive. It appears, however, that one of the most frequent causes of Westinghouse meters humming loudly, or rattling, has been omitted from this article. Reference is made to the pinion on the disk shaft meshing too deeply with the next wheel in the train. This condition throws, or tends to throw, the cup-jewels out of line, and excessive humming or rattling is the result.

The writer believes, however, that in the majority of cases the rattling in these meters is due to some defect which tends to throw the jewels out of line, or keep the shaft from resting freely on the lower bearing. The main object is to give the bearing ball a chance to adjust itself freely in the cups.

The close meshing referred to may be relieved by putting paper shims under the register supporting plate, between the plate and the studs.

AUTOMATIC RE-CLOSING DEVICE FOR AUTOMATIC SUBSTATIONS.

Details of Re-closing Mechanism Developed by Southern California Edison Company for Substations Without Attendants.

By B. F. Pearson.

General Superintendent, Southern California Edison Company.

The increasing use of electrical energy in larger amounts, the higher quality of service demanded and rendered, higher labor costs, and so on, have all combined to cause to come into existence many isolated stations where labor is lacking and the equipment is without attendance. Many of these stations have been equipped with automatic devices which will operate as a last resort on overload. One of the difficulties in the past with substations without attendants has been to protect a piece of apparatus against undue severity of service and at the same time not permit unnecessary interruption of service nor for a longer time than can be avoided.

The use of fuses, while protecting apparatus, causes

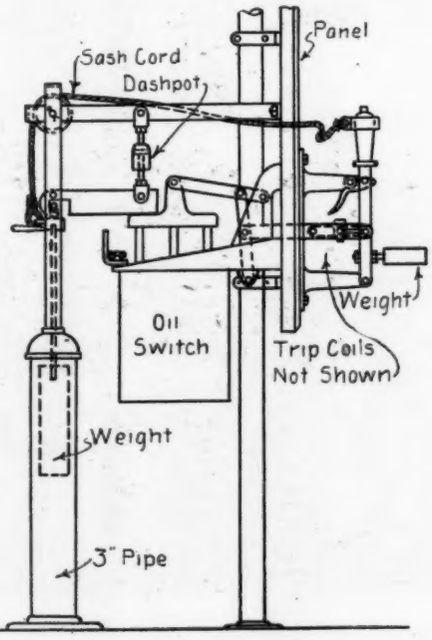


Fig. 1.—General Scheme of Automatic Re-closing Oil Switch Mechanism.

delay until such time as they may be replaced. Many installations cannot countenance such delays, and, moreover, a fuse may blow due to a transitory overload or short-circuit, or swinging short-circuit, which would have passed before harm happened to apparatus. The same applies to oil circuit breakers protected by overload relays.

A simple and inexpensive device has been recently developed by the Southern California Edison Company, the purpose of which is to automatically re-close automatically-operated oil circuit breakers installed in stations without attendants.

This device is an attachment for application to

2200-volt oil circuit breakers which closes the switch after it has opened on account of a case of trouble. If an oil circuit breaker opens under heavy current it remains open for one-half minute. The one-half minute that is allowed to elapse before the switch closes is to permit trouble to clear, motor control apparatus to return to the non-running or starting positions, and so on. The time element of one-half minute is obtained by means of dashpots, illustrated in Figs. 2 and 3.

The closing mechanism consists of a weight which is fastened to the oil-switch lever by means of a sash cord passing over a pulley and passing through the switchboard. When the breaker opens the weight drops, and in doing so draws up the oil-switch lever, tending to close the oil switch again. However, the dashpot retards its closing until the half-minute has elapsed. If the breaker opens again because the trouble still remains, the automatic re-closing device does not work because the weight is already dropped and cannot drop again until reset.

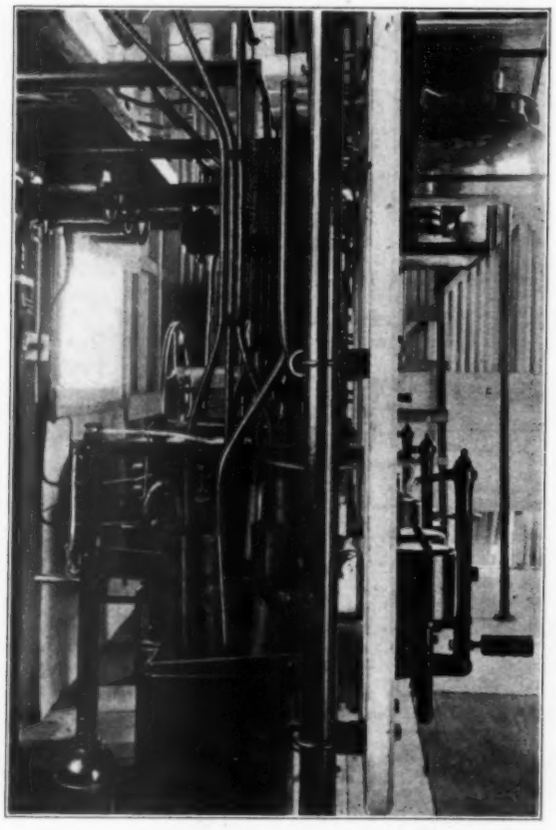


Fig. 2.—View of Re-closing Mechanism From Rear of Switchboard.

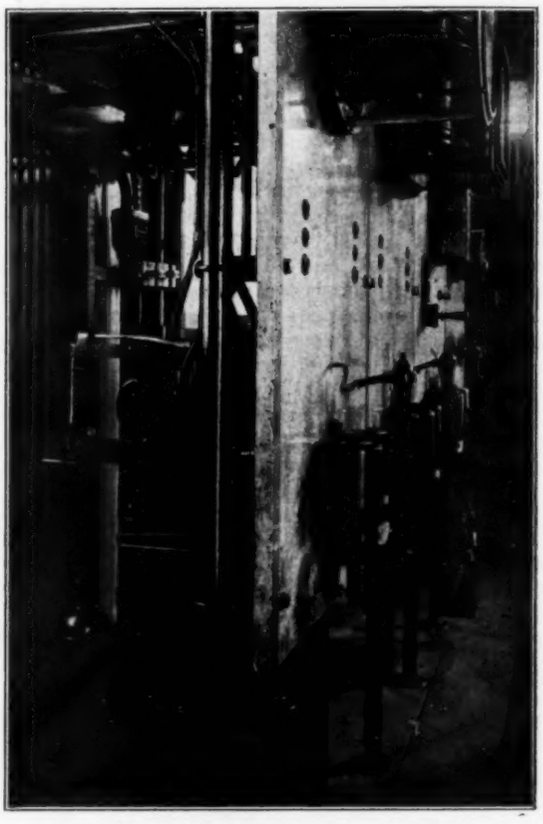


Fig. 3.—View of Re-closing Mechanism From Front of Switchboard.

The scheme upon which this re-closing device operates can be understood by referring to the outline of the arrangement shown in Fig. 1. The general details are illustrated in Figs. 2 and 3. The operating mechanism is mounted upon a section of 3-inch pipe placed at the rear of the switchboard. The sash cord passes through the marble board and over an easily running pulley so located that the cord will not become abraded due to friction in passing through the marble. The device has proved very satisfactory for use in substations without attendants, reducing needless service interruptions and trouble calls, yet not jeopardizing equipment.

WAR RESTRICTIONS ON NEW ELECTRIC SUPPLY CONNECTIONS.

In addition to rationing consumers of electricity for light and heating with a view to saving coal, the British government is taking special measures to reduce the demand for power. As far as possible, new connections will be limited to requirements for urgent war purposes. In any other cases applications for priority certificates to enable consumers to purchase motors and other electrical plant requiring supply from public mains, will have to be accompanied by a certificate from the chief engineer or manager of the undertaking concern stating: (1) That adequate generating plant capacity is or is not available; (2) that an additional cost or material is involved in connecting the premises to the mains, including substation equipment, if any; or (3) whether expense is involved, the material and apparatus to be provided, and the cost thereof, and whether lead covered cable is necessary or not. Where lead covered cable is deemed necessary the voltage of the current transmitted is to be stated.

CREDITABLE TURBOGENERATOR PERFORMANCE.

Unit No. 3, at the Northwest station of the Commonwealth Edison Company, a 30,000-kilowatt G. E. turbogenerator, was recently shut down for inspection and overhauling. Previous to this the unit had been in service for 2½ years without overhauling or inspection, and during which time it generated 475,000,000 kilowatt-hours. The incident speaks well for the reliability and suitability of the modern turbogenerator.

Contracting-Construction

Croft's Remarks on Conduit Benders—Code for Electrical Appliances—Handy Shimming Kink—Among Contractors

SOME COMMENTS ON CONDUIT BENDERS.

Principal Types of Conduit Benders—Where They Should Be Used—Advantages of the Simple Hickey.

BY TERRELL CROFT.

[*This is the first of a series of articles describing different types of conduit benders and commenting on their use. These articles form a suitable sequel to the seven articles on "Methods of Bending Conduit," by the same author, which appeared in the* ELECTRICAL REVIEW *of January 12 to February 23, 1918, inclusive.*]

Conduit Benders May Be Divided into Four General Classes, as follows: (1) hickeys, (2) bending racks, (3) pressure benders, and (4) roll benders. Each of these types will be defined in paragraphs immediately following and then, in subsequent sections, examples of the different kinds of benders will be discussed in detail.

A Hickey is a hand bender (it is really a sort of a lever) having a hole or slot at one end, wherein the conduit to be bent may be engaged. In using this tool, a portion of the conduit is held to the floor by the operator, who stands on it, and then, by using the hickey

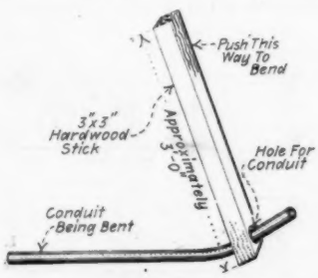


Fig. 1.—Bending Conduit with a Hardwood Hickey.

as a lever (Fig. 1), the conduit which is engaged in its lower end is bent by main force into the required form.

A Bending Rack or Vise is an arrangement into which one end of the conduit is inserted and there rigidly held while force is applied to the other end to bend the tube into the required form. Fig. 2 illustrates a typical example.

Pressure Benders (Fig. 3) are those whereby conduit, particularly large conduit, is formed into curves by the direct application of pressure against the conduit (which is supported as a beam) at the location where the bend is to be made. Usually the pressure is exerted against the tube through a bending head or form. The pressure may be developed by means of a jackscrew or by a hydraulic or pneumatic cylinder or piston.

A Roll Bender (Fig. 4) is one wherein the conduit is rolled by suitably arranged bending rolls, or drawn by a rotating cam properly arranged, into the required contour.

Typical examples of conduit bends are shown in Figs. 5 and 6, which indicate the contours into which the tubes must be most frequently formed for interior wiring installations. Credit for these two illustrations is due to G. E. Phillips, of the MacKenzie Electric Company, Sarnia, Ont., Canada.

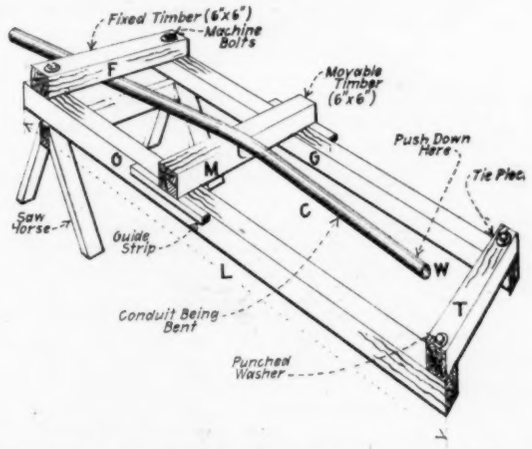


Fig. 2.—Bending Rack Constructed from Heavy Timbers.

WHERE THE DIFFERENT TYPES OF BENDERS ARE MOST SUITABLE.

The applications of each of the four different types of conduit benders are described in detail in following paragraphs. Briefly, they may be outlined thus: Hickeys are used for light work, ordinarily for conduits not greater than ½ inch or ¾ inch, where it is desirable that the tool be carried to the work rather than the work to the tool. Bending racks or vises are also used to best advantage for the conduits of the

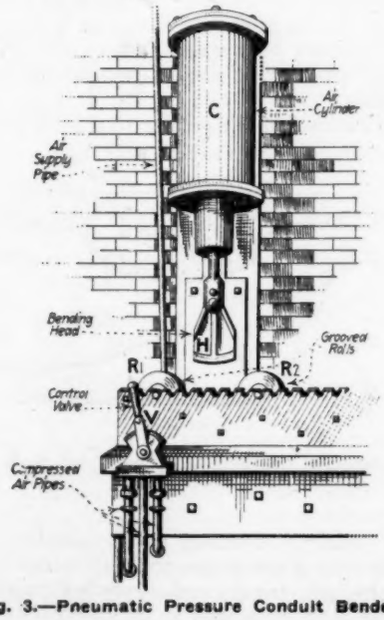


Fig. 3.—Pneumatic Pressure Conduit Bender.

smaller diameters, but may be used, though not economically, for large-diameter conduits. With them bends, unless they are irregular, can be formed more rapidly than with the hickeys, but the racks have the disadvantage that they must be located securely in position and that the work must be carried to them. Pressure benders are used for the large-diameter conduits where it is impossible to obtain the force required for bending without some sort of a machine, and sometimes for small-diameter conduits where hydraulic or pneumatic power is available whereby the tubes may be bent quickly and economically without the exertion of manual force. Roll benders find their most important application for the larger-sized tubes because, with them, bends in conduits up to even 4 inches in diam-

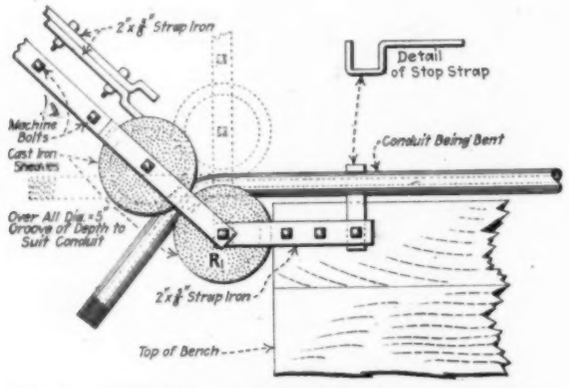


Fig. 4.—Grooved-Sheave Bender Mounted on Bench Top.

eter can be made uniformly and accurately, without heating the conduits.

The Simple Hickey and Its Advantages.

The advantage of the hickey is that it may be carried to the location where work is being done. Where benders of the rack, pressure or roll types are used, it is necessary to carry the work to the bender. A wireman can carry readily, in his tool box, the head for a commercial hickey or, instead, a 1-inch or a 1¼-inch pipe tee. On the job he can usually find a piece of pipe of the correct diameter to serve as a handle and thus assemble the complete tool. It is apparent then that hickeys have an important field of usefulness regardless of whether or not benders of the other types are available.

The Wooden Hickey or Bending Stick is illustrated

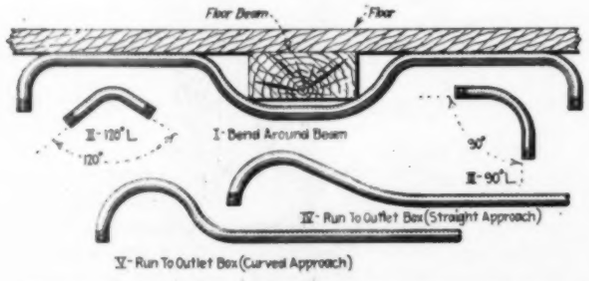


Fig. 5.—Some of the Conduit Bends Which Must Be Made Frequently.

in Figs. 1 and 7. A hickey of this design is not to be compared with a metal one for continuous service, but can, particularly for ½ and ¾-inch conduit, be made to do good duty, especially in an emergency. The tool consists merely of a stick which should be of hard wood (hickory is excellent) about 3 by 3 inches square and 3 feet to 3 feet 6 inches long. An ordinary 2 by 4 can be used, if nothing better is available. Holes are bored in the lower end of the stick, as detailed in

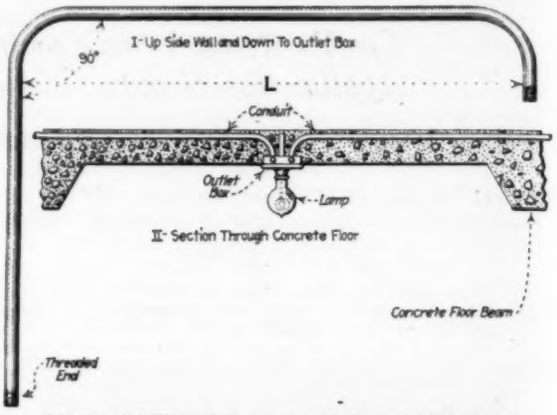


Fig. 6.—Additional Examples of Conduit Bending.

Fig. 7. If only ½-inch conduit is to be bent, only one hole, and that just large enough to accommodate the ½-inch conduit, is necessary. If more than one size of duct is to be bent, holes of different diameters should be bored as suggested. These must not be too near together, or else the wood between them will break out. It is well to round off the opposite edges of the holes on opposite faces, as indicated in Fig. 7, to prevent the kinking of the conduit being bent. The disadvantage of a hickey of this construction is that, after it has been in service for some time, the pressure

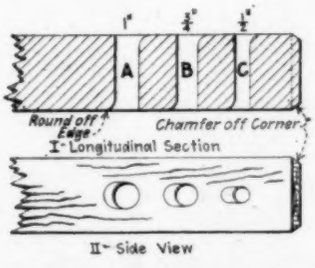


Fig. 7.—Method of Boring Holes in a Wood Hickey.

of the conduit against the wood fibers at the side of the holes so enlarges the holes at that point that the stick will no longer grip the tube.

(To be continued.)

CODE FOR ELECTRICAL APPLIANCES.

Underwriters' Laboratories, Inc., Issues First Volume of Its Code for Construction and Test of Electrical Appliances.

As the result of development over a period of many years a series of standards for the design, construction and testing of devices and materials for use on electric circuits for light, heat and power has been issued by Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago. These standards at present cover 11 classes of electrical products and have been included in a well-bound volume designated as "Underwriters' Laboratories Code for Electrical Appliances." This code also includes standards for the forms of supervision of such products marketed under inspection and listing for the Laboratories. A preliminary section is

also included, giving information regarding the organization of Underwriters' Laboratories, its object and work, its Electrical Council and Electrical Industry Conference, promulgation of test results, re-examination and label service, etc.

Each of the standards consists of three sections, the first being the general section dealing with the Laboratories' work just referred to. The second section deals with the Industry Conference for the particular class of products, use of labels on inspected products, and inspectors' reports. The third section gives the Laboratories' specifications for the construction and methods of testing of the class of appliances, which are based on the requirements of the National Electrical Code, and details the procedure in the work of inspection at the factories and the use of labels. The third section as a rule is the most comprehensive, as it contains the full technical requirements that must be met by each class of appliances, and the details of the standard tests applied thereto. At present, this code contains 11 standards on the following classes of electrical materials: rubber-covered wires and cables, rigid conduit, armored cables and cords, cartridge inclosed fuses, snap switches, cabinets and cutout boxes, electric signs, panelboards, knife switches, cutout bases, soldering lugs. These standards include a wealth of information on the details of construction of electrical appliances so as to make them safe from fire and life hazards. Tests of both simple and intricate character are described to insure that the products correspond to the specifications of the standards.

This code is published as Volume 1, evidently indicating that other future volumes will contain similar standards for the numerous other classes of electrical appliances. The volume is handsomely bound in green leather and arranged so that new or revised pages can be readily inserted. The present volume contains 382 pages, 6 by 9 inches. The different standards are easily located by marginal guides. Copies of the code have been furnished by Underwriters' Laboratories to electrical inspection departments, national electrical associations, societies and institutes, the Bureau of Standards and Bureau of Mines. Copies can be obtained by private individuals for $10 per volume. Copies of individual standards are furnished to manufacturing concerns whose products belong to the particular class affected by the standard and are tested by the Laboratories.

HANDY SHIMMING KINK.

By Charles H. Willey.

On one occasion it was necessary to do some rebabbitting and overhauling of the bearings of one of our 350 kilowatt generator engines. Being short of sufficient shims to give necessary clearance distance between the bearing cap and shell, and wanting permanent liners, it was desired to make them of brass or copper. As no suitable material could be found, material had to be improvised. The sketches in Figs.

Figs. 1 and 2.—Split Brass Pipe and Shim Made Therefrom.

1 and 2 show how this was done. Some short lengths of ¼-inch brass pipe were procured, split it as shown, and after annealing and flattening it, filed it to the shape desired. Scrap pipe makes very good sheet brass when needed.

AMONG THE CONTRACTORS.

Pearson & Westberg, Rockford, Ill., lately completed the wiring and installation of fixtures in the Grand Billiard Hall, the fixtures being those made specially for billiard-table lighting. The job amounted to $2000.

The United States Government has awarded a contract to the Turner Construction Company, 244 Madison Avenue, New York City, to construct an underground distributing system and power plant at G and 25th Streets, Washington, D. C., at a cost of $550,000.

Frank R. Ward, Rockford, Ill., lately rewired the building of the Ward Pump Company, changing from open wiring to a conduit system, and installed ten motors amounting to 200 horsepower. He also put in there an interconnecting telephone system.

W. J. Walker, Elgin, Ill., is about completing the wiring and motor installations in the new foundry of Woodruff & Edwards, whose old foundry was destroyed by fire some time ago. There are new motors amounting to 167 horsepower. Power is derived from the firm's own hydroelectric plant, consisting of two generators of 45 kilowatts each, driven by two water wheels. The plant is on the Fox River.

The Pierce Electric Company, 215 West Randolph Street, Chicago, Ill., is doing the complete wiring on a large new substation for the Chicago municipal street-lighting system. It is located in the northwestern part of the city and will supply a very large district. The incoming lines are 12,000 volts, three phase, 60 cycles, all outgoing lines are series, constant-current circuits for series Mazda street lamps.

Floyd C. Schmitt, contractor and appliance dealer, of Aurora, Ill., has in progress the wiring and fixture and motor installations in the Mercyville Sanitarium in Aurora, which amount to $2500. There are 300 outlets for lights and 30 horsepower in motors, the latter being for pumps, laundry and fans. The work includes all electrical equipment. He recently completed the wiring of the Aurora Bleaching & Dye Works for nitrogen-filled lamps. There are 200 outlets. The job amounted to $1700.

Strom Electric Company, Joliet, Ill., has completed for the General Refractories Company, near that city, a contract that ran up to $12,000. The work consisted in wiring for power and light the latter's new plant buildings, and the installation of General Electric motors amounting to 800 horsepower, connecting same to crushers, blowers, grinders and other machines; and putting up a General Electric switchboard. There are about 500 lights arranged for on the premises. The Strom company now has in hand the rewiring of the Monroe Hotel at Joliet, which amounts to about $2000.

Russell & Company, 56 West 45th Street, New York City, have been awarded the contract for the electrical work in the new residence at Roslyn, Long Island, being built for Frank C. Henderson. This work consists of the complete electric light and power wiring, and includes special cove lighting and lighting of the grounds and out buildings. Annunciator and telephone systems are also to be installed. The company also has a contract for the new apartment building at 89th Street and Avenue A, New York City, consisting of 20 apartments with the customary electric lighting and bell work.

QUESTIONS AND ANSWERS

All readers are invited to submit questions and answers to this department. Anonymous communications will not be considered. Questions should relate to electrical matters of any kind. Answers contributed by readers should be submitted preferably within eight days of the date of publication of the question and should be limited, if possible, to 300 words. Payment will be made for all answers published.

Questions.

No. 425.—Copper-Covered Wire for Naval Use.—Is copper-covered wire used upon ships, in the navy especially, for electrical purposes, where strength is required, such as for antennae of wireless outfits? The writer has heard it stated that copper-covered wire is unable to stand up in salt-laden atmospheres, and where corrosive fumes from the stacks of battleships have to be withstood. Is this correct, and what metal supplants copper for this class of service?—P. M. C., San Francisco, Cal.

No. 426.—Inclosed Switch.—Is there any warrant for an inspector insisting on use of an ironclad or inclosed knife switch for a three-phase, 220-volt, induction motor where a careful operator is always close at hand and no one else is permitted to come near the switch, which is on a post close to a special machine under the care of the operator?—H. S. C., St. Louis, Mo.

No. 427.—Storage Battery for Exit Lights.—A storage battery is provided as an emergency source for the exit lights of a theater, which is normally supplied from the central-station lines. The battery is to be charged by a small special motor-generator. The house electrician has been advised to charge the battery once a week, even though it is practically never connected to the lights. Is this not excessive? How often is it advisable to charge the battery under these conditions?—J. B., Newark, N. J.

Answers.

No. 420.—Time Studies in Electrical Construction.—I would like to inquire whether any of your readers ever have made, or know of any one having made, a time study of the labor elements of installing conduit, boxes, etc., for electric wiring. If so, from whom and in what form are these data available?—R. M. E., St. Paul, Minn.

Answer A.—During my experience as an electrical contractor, covering a period of 20 years, I have never succeeded in making or heard of any one who had been able to make out a dependable schedule that was applicable to this line of work to show the relative time for installing the many electrical fittings. This is for the reason that there is such a great difference in the ability of the men assigned to this class of work; note, for example, the different kinds of workmanship of different men on socket work, wall cabinets and wall boxes. Now all this is standard and could be classified, but I have seen what are called first-class wiremen do a certain amount of work along these lines taking them two hours; I have had the same work repeated, conditions exactly the same, and the men manage to make half a day over this same work. Of all the many men I employed during my experience I found two men only who could do any and all work assigned to them and do it speedily, right and in first-class condition. I held them with me for 15 years. Experts on lighting and power plant and switchboard work also differ widely. I would advise to seek and hire only good men, pay them well, and hold onto them, and you can soon get a line on your men in a way that you can form an idea of the value of their services that will enable you to figure correctly when making a labor estimate in submitting bids on contract work.—F. F. H., Milwaukee, Wis.

Answer B.—The writer submitted data covering the cost of labor in per cent of material cost, also cost of labor for pulling in heavy conductors, and the cost of conduit bending, which were published in the Electrical Review and Western Electrician of March 27, 1915, page 585. These costs were made from time studies taken in Minnesota, Illinois, Wisconsin and Indiana during 1912, 1913 and 1914.—H. E. W., Chicago, Ill.

No. 422.—Motor-Starting Trouble.—A plant supplying a small town with power and light contains the following equipment: Two 37½-horsepower high-speed engines, running 350 revolutions per minute and driving two belt-driven 20-kilowatt, 60-cycle, 2300-volt, 1800 revolutions per minute generators. Two exciters belted to the generators give 90 volts. The switchboard is equipped with voltmeters, ammeters, rheostats, but no regulators for the machines, voltage regulation being done by hand. Primary lines are of No. 8 copper. At about 500 feet from the power house the first transformer of a bank of three 7½-kilowatt units connected in closed delta is taken off; they supply 220-volt power to an elevator motor 1000 feet distant from the power house. The next transformer is 150 feet farther on toward the elevator and the last one in the bank is 250 feet from the elevator. Secondary lines are No. 8 copper clear to the motor. The motor is 5-horsepower squirrel cage with no starting device. When attempt is made to start the motor without load and with no friction on bearings it pulls the line voltage down from 220 to around 100 volts and holds at this point for about three seconds, when it begins to build up, and at the end of ten seconds returns to 220. The motor will then be running. It not only pulls down the secondary voltage but also the primary voltage so that the entire system is affected. The engine also shows an appreciable decrease in speed, but as no proper speed indicator is available, it is impossible to tell how great is this drop in speed. The engine flywheels weigh about 250 pounds each and we surmised that they are so light as to be unable to withstand the sudden jar of the motor being thrown on. The motor will pull 5 horsepower when up to speed but will not start itself. We do not know where the trouble is located, on the line, in the power house or at the motor.—B. A., Watertown, S. D.

Answer A.—The starting trouble is due to several causes. In the first place, the location of the transformers is wrong and, on account of the variation in the length of the secondary wiring, there will be unequal drops in the three phases. The secondary lines are too small considering their length, and most of the drop is due to this cause. The starting torque of an induction motor varies as the square of the impressed voltage, and therefore if the voltage is reduced to one-half normal, the starting torque will only be one-quarter of what it would be with full voltage. The chances are that the motor is a standard power motor designed for high efficiency and comparatively low starting torque; such a motor, if thrown directly across the line, will take five or six times full-load current, and this would be considerably more than the equipment could be expected to furnish if there is a reasonable load on the system at the time the motor is thrown on.

A compensator could be used to limit the starting current, thereby reducing the line drop, but it is very likely that the motor would not be able to start the elevator under these circumstances. Special induction motors are made that have high-resistance rotors and give the maximum torque at starting, at the same time the maximum current is limited by the high resistance of the motor itself. These motors are not so efficient as the standard type. The station equipment is so small that great care should be taken to see that any motors installed are provided with proper appliances to limit the starting current and low-voltage protective devices should also be employed if good regulation is to be assured. The transformers should be placed together and close to the motor, then with a correct motor starter, starting should be possible, but the

equipment is too small to expect good regulation when the motor is thrown on.—C. H. H., Swampscott, Mass.

Answer B.—The chief trouble in this case is caused by having the three transformers located quite a distance apart instead of in a bank or group close together. Transformers feeding three-phase motors are always placed in a bank right close to the motor. If placed some distance apart, as in this case, the primaries of the three transformers do not receive the same voltage, especially when there is a heavy load like the starting current of a squirrel-cage motor. This unequal voltage on the primaries causes heavy cross currents between them, it also causes unbalance and heavy cross currents between the secondaries so that the resulting voltage impressed on the motor is greatly reduced. This in turn increases the current necessary to develop the necessary starting torque and aggravates the trouble. By placing the transformers just outside the elevator in which the motor is installed the unbalance will be reduced to a minimum and the necessity for installing a starting compensator for the motor may be eliminated. If lighting circuits are fed from the same transformers it will be better to feed them back from the bank at the elevator than to incur the liability of unbalance and excessive drop in the secondary caused by a location some distance from the motor. It will be desirable also, so as to reduce the starting current and therefore the disturbance to the voltage of the system, to place a starting compensator at the motor. The chief cause of the violent disturbance to the entire system, however, is the unbalance due to not having the transformers properly placed, as already described above. Relocation of the transformers for the motor and use of a starting device should almost entirely relieve the trouble. If there is too much drop in the lighting circuits from having them fed back from the power transformers at the elevator, place small lighting transformers where the lighting circuits can be most advantageously tapped off the main line.—B. H. F., Evanston, Ill.

No. 423.—Iron Bars for Busbars.—An order was received for a new switchboard containing voltmeter, ammeter, main switch (fused for 400 amperes), ground lamps, pilot lights and four circuit switches. Being unable to obtain copper for the busbars, flat iron was used, having seven times the cross section of the intended copper, with joints scraped and bolted together. The board was inspected and passed by the local inspector under Rule 2, section *b*, second paragraph, of the 1915 Code. Several weeks later this same inspector called and stated his office claimed all busbars must be of pure copper, and that the inspection department would not approve a substitute that might start a bad practice among contractors and switchboard builders. Reference was made to rules 18, 49 and 57. In none of these rules is it stated that conductors must be made of copper, only in Rule 18 it shows the carrying capacity of wires and cables of 98 per cent conductivity. The firm using this switchboard is working on special war orders for the government and if unable to get a ready-made board or copper busbars must shut down or pay hazardous insurance rates. I would appreciate opinions from some authority on this subject, as it has been impossible to obtain satisfactioon from the electrical engineer of the underwriters.—L. G., Dubois, Pa.

Answer A.—L. G. does not state whether his switchboard is part of an alternating or direct-current installation, but I presume it is direct-current. Barring stray magnetic fields which may cause incorrect readings of his switchboard instruments on account of the increased magnetic flux, there is no good reason why iron bars cannot supplant copper for switchboard busbars, if they are laminated and of sufficient current-carrying capacity. Rule 2, section *b*, purposely is constructed in that manner to meet different conditions which are constantly arising, such as the present almost prohibitive price of copper bars. If such were not the case it would read "Busbars must be of copper, but may be bare." In my territory, I would not hesitate approving such an installation, if on a direct-current system under proper conditions, but if the electrical inspection is under the jurisdiction of the local insurance company I am afraid L. G. can do nothing but comply with its demands. I would suggest, however, that he state the conditions to the National Board of Fire Underwriters, 76 William Street, New York City, and if he can obtain a letter confirming the stand he takes, no doubt it may bear weight in influencing the local company to rule favorably. Basing electrical inspection on life and fire hazard, the hazard is no greater with bare iron, if properly installed, than with copper.—A. P., Chicago, Ill.

Answer B.—There is always a most important and essential point to be considered in connection with any electrical work that is subject to inspection, regardless of how advantageous or safe it may be and installed in accordance with the rules and requirements of the city inspector and Board of Fire Underwriters. If either have an objection over a matter of this kind, it is almost useless to put up any argument or seek authority over their decision. But in this case I can assure you results entirely satisfactory if you will copper-plate heavily the iron bars, these keeping within reasonable cross section and safe carrying capacity compared with copper busbars. The results obtained in the majority of cases under proper conditions will be equal to the all-copper bars. During my experience as an electrical contractor (20 years) I frequently was obliged from necessity and when suitable copper was not available, to use the iron bars plated as described with perfectly satisfactory results, with no appreciable loss of current or undue heating, two most desirable and necessary items to be provided in connection with heavy tie-bar or switchboard work. My field of work for many years was in the city of Pittsburgh, Pa., and vicinity. The plating as described passed inspection but I took care not to abuse the privilege granted and only did so where unable for good reasons to obtain the copper.—F. F. H., Milwaukee, Wis.

Answer C.—There are two sides to this question. The construction described, if made in a workmanlike manner with joints of higher conductivity than the bar section itself (to allow for possible deterioration and increase of resistance and therefore heating) and with ample cross section (to allow for the greatly reduced conductivity of iron compared with copper), would probably be a satisfactory one, certainly for an emergency installation. No inspector, however, can be blamed for hesitating to give general approval to an installation of this kind unless he is absolutely certain that the carrying capacity of the bars is ample, that the joints are of liberal area and properly made, that they are protected from rusting or corrosion, that the bars are designed and constructed to minimize eddy-current and hysteresis losses on alternating-current boards—in short, that no source of dangerous heating is likely to develop. To make sure of these points, the inspector would have to make a very thorough examination, also tests of the conductivity of the bars and their joints. Because of the many variables that enter, the inspector is likely to prefer to reject an installation of this kind than run the risk of approving it and find later that trouble has developed. Especially does he look askance at any use of iron busbars because by plating them with copper they may be made to look practically like copper bars, so that an unscrupulous contractor may try "to put one over on him."—J. B., Buffalo, N. Y.

BOOK REVIEWS

"Telegraph Practice: A Study of Comparative Methods." By John Lee. New York: Longman, Green & Company. Cloth, 112 pages (4⅞x7¼), 151 illustrations. Supplied by Electrical Review Publishing Company, Inc., for $1.00.

Written by the Postmaster of Belfast, who previously had been deputy chief inspector of the telegraph and telephone Traffic at the General Post Office in London, this volume relates to telegraph practice in the administrative sense, as distinguished from the mechanical or electrical operations of telegraph apparatus. As might be expected, it discusses the British practice more particularly, but abounds in comparison of methods adopted by different administrations in Great Britain and to some extent also compares this with the practice in America and in other parts of Europe. Moreover, this volume clearly shows the influence on telegraph practice both of government ownership and of the joint control of telegraph and telephone systems. It therefore is timely and interesting to American readers also, in view of the strong tendencies in this country towards government operation.

After an introduction in which the author distinguishes between improvements due to a scientific study of conditions and others due to the governmental articulation of public needs, the author first discusses the acceptance of telegrams from the public, including the British method of permitting senders to have specially printed forms, and the London practice of registering abbreviated addresses, which latter was the logical outcome of the charge for addresses. Transmitting of telegrams by telephone, designated in England as "phonograms," is also discussed here, and the author foresees a future in England for a night telegraph letter corresponding to the American practice.

Interesting chapters are devoted to the centralizing of telegraph traffic, including the use of pneumatic tubes and the possible prospective use of aeroplanes for collecting messages, and to the organization of the telegraph system as affected by the amount of traffic between different points. Differences in practice as to telegraph instrument rooms and telegraph instruments, including automatic sending and receiving instruments, are discussed in an interesting manner. Then follows a chapter on the delivery of telegrams, in which the author favors a differentiation in the charge according to the urgency of the message and the corresponding differences in the time of handling and delivery. In this connection, the author quotes British practice as showing that the flow of telegraph practice from subscribers coincides with the ordinary telephone peak load, so that overflow telephone arrangements are advisable to take care of the telegrams which are spoken for delivery.

Further chapters on press telegrams, telegraph traffic, and particularly the closing chapter on the future of telegraph practice are both interesting and effective. Here the author points out that telegraph practice has only made its proper beginning within the last few years, and only in the United States, and that the old mental shackles which have bound telegraphy in the past are only now being burst, owing to the effect of the war in bringing United States methods of telegraphy into greater prominence in England and in acquainting American telegraphers with European practice.

"The Calorific Power of Fuels." By Herman Poole. Third edition, rewritten by Robert Thurston Kent. New York: John Wiley & Sons, Inc. Cloth, 267 pages (9x6 inches, illustrated. Supplied by Electrical Review Publishing Company, Inc., for $3.

Available data on fuels, and even the use of new fuels in increasing extent have both multiplied to such a degree within the last 17 years that it has been found desirable that "Calorific Power of Fuels" should be almost completely rewritten. This has been done by Robert Thurston Kent. Much of the valuable information made available by researches of the Geological Survey and Bureau of Mines have been added to make the book more complete and therefore more valuable.

There are 11 chapters in all. The first four cover quite fully the subject of calorimetry. One chapter is devoted each to solid, liquid and gaseous fuels. Next follows a chapter on the combustion of coal, in simple language with explicit reasons as to the why and wherefore, such as any average power-house engineer or engineering student should be able to follow. The next chapter deals with the calorific value of coal burned under steam boilers, which, as all through the book, is concisely yet quite fully covered. The last chapter treats of the analysis and measurement of the properties of combustion which includes, of course, description as to various types of carbon-dioxide recorders, pressure gauges, and so forth. There is an appendix of 43 pages, and a very complete index completes the book. The appendix covers, amongst other things, the A. S. M. E. Power Code, factors of evaporation for dry steam, specific heat of various gases, liquids, metals and other solids, and many other tables and data pertaining to combustion engineering and physics.

The book appears to have been carefully revised. The inclusion of information on peat, lignite and various forms of gaseous fuels is most timely. It is to be regretted, however, that more information is not included as to the actual burning of many of these newer forms of fuel such as have come into increasing use in Europe especially, and to a lesser degree here. However, the book deals with the calorific power of fuels, not boiler-room design. The substitution of English units—the British thermal unit and pound—in place of the metric units—calorie and kilogram—is, in the writer's opinion, a backward step. The inclusion of the English units will undoubtedly prove more serviceable to many readers, but internationalization of terms, the better understanding and closer cooperation between allies should make it preferable to employ both units. And then the metric units are so much more flexible and less unwieldy than the English. The book is, however, ably gotten up in most commendable form by one evidently a master of his subject. Moreover, it appears at a time when throughout a large part of the world the question of fuel occupies greater importance and prominence than it ever has before. The book fills a long-felt want and should find its way into the bookcase of every engineer and student of combustion engineering, for the reading matter accomplishes what the name of the book implies.

I. L. KENTISH-RANKIN.

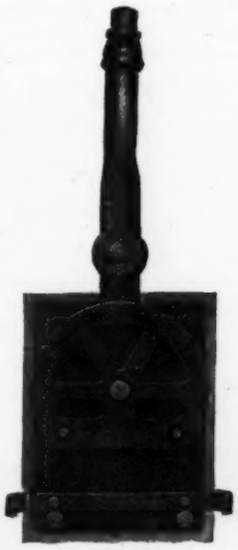
The Puget Sound Traction, Light & Power Company, Seattle, Wash., when its present development is completed, will have a total hydroelectric capacity of 107,997 horsepower. There will also be 38,264 horsepower in steam plants, making a combined capacity all told of 146,261 horsepower.

New Appliances

Conduit Bender—Floor Polisher—Suction Cleaner—Fuse and Switch—Sewing and Washing-Machine Developments

WHITECOTTON PIPE AND CONDUIT BENDER.

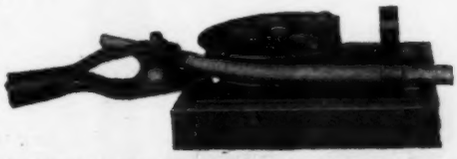
The Akron Electric Construction Company, of Akron, Ohio, has placed on the market the Whitecotton pipe and conduit bender, which is shown in the accompanying illustrations. Among the principal points of superiority claimed for this bender are simplicity, great ease of operation, smoothness and precision of its work. By use of it bends are made from either the right or left side without readjustment, and to any degree from 1 to 180. Other special advantages



Top View of Whitecotton Pipe Bender.

are speed of operating, resulting in no kinks, nor flattened conduits, and any number of pieces may be bent of exactly the same length, provided no mistakes are made in measurement.

The outfit is strongly made, yet light in weight. The small bending wheel has roller-pin bearings, eliminating friction. The open construction allows the conduit to be inserted and withdrawn with ease. This bender should be very useful to electrical contractors, plumb-



Side View of Bender, Showing Conduit Being Bent.

ers, steam fitters and others having much conduit or pipe to bend. It was designed and patented by Oscar Whitecotton, an experienced electrician and mechanic, and now manager of the Akron Electric Construction Company.

DALE-REY ELECTRIC POLISHING MACHINE.

The Dale-Rey Corporation, 25 Church Street, New York City, is manufacturing a polishing machine for use on hardwood or linoleum waxed floors. The machine was designed originally for the New York Telephone Building, and its use by the owners of this large structure has enabled them to employ women instead of men in waxing and polishing wood and linoleum floors. This work is important because the waxed, polished floor, besides being more sanitary, is less expensive to care for than the floor subject to mopping and scrubbing. It is especially desirable in maintaining hospital floors.

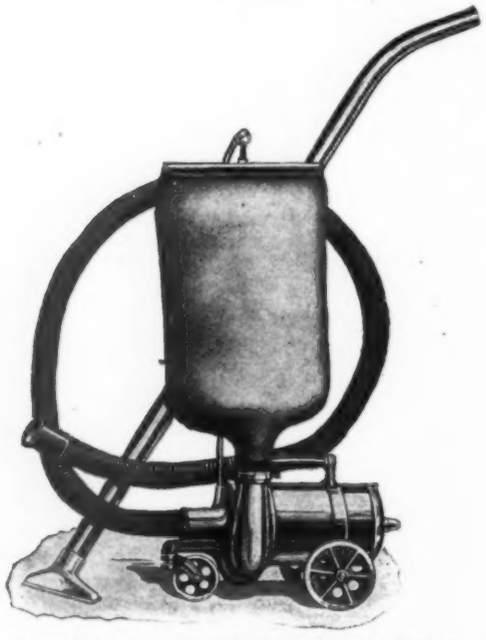
Electric Floor-Polishing Machine.

The polishing machine, a cut of which is shown, weighs about 100 pounds, is 9½ inches high and 19 inches wide, is mounted upon rollers and is moved over the floor with little effort. Within is a cylindrical brush, driven at high speed by a ¼-horsepower motor. The brush is made of two semicircular aluminum cylinders, mounted upon a drum of the same metal, revolving on Hess-Bright ball bearings. Cylinders and motor are connected by a chain and sprocket wheel. The brush is set to revolve at right angles to the plane of the floor, giving a buffing action that reduces the amount of wax required.

The essential advantages of the outfit are the superior work and reduction of labor costs. The design of this machine originated in the great necessity for eliminating all dust from floors occupied by telephone apparatus. The outfit has also been found highly serviceable for hospitals, high-class office and public buildings, hotels, club houses, large residences, etc.

NEW MODEL OF BISSELL ELECTRIC SUCTION CLEANER.

Herewith is given an illustration of the new Model D Bissell electric suction cleaner, manufactured by the Bissell Motor Company, Toledo, Ohio. Model D is a modification of Model C, which stood seven years' testing and service with very few changes. The new



New Model D Bissell Electric Suction Cleaner.

model retains all the good features tested and proved out in the old model, such as the powerful suction and ease of operation, and embodies some special improvements. It has an aluminum frame, whereby the weight of the machine is much reduced. The three floor wheels of Model D, instead of being of metal with rubber tires, are entirely of hard rubber, the grinding wheel being in front; and the wheels are of greater diameter than those of Model C, making easy movement of the cleaner an important factor. Hard grease, as lubricant, is fed through a wick to a ground steel shaft running in a phosphor-bronze bearing. The manufacturers have been very successful in their efforts to interest electrical dealers in actively pushing the sale of Bissell cleaners and it is believed this new model will have a still greater sale.

COMBINED FUSE AND DISCONNECTING SWITCH FOR OUTDOOR SERVICE.

In connection with the operation of small outdoor substations the combined fuse and disconnecting switch here shown is used primarily for the protection of transformer banks where no primary switches are required.

The fuse is suitable for opening the exciting current of transformer banks not exceeding 300 kilovolt-amperes. Secondary switches should be provided so that the load can be removed in case it should become necessary to open the primary side with the fuses.

The fuse holder is removed by a fuse hook from the ground. To open the circuit the holder is lifted completely out of the contacts by the fuse hook which is so constructed that the fuse holder will hang vertically when held by the hook. Then, if desired, the upper end of the fuse holder is inserted in and hangs from the cap partly surrounding the lower contact clips.

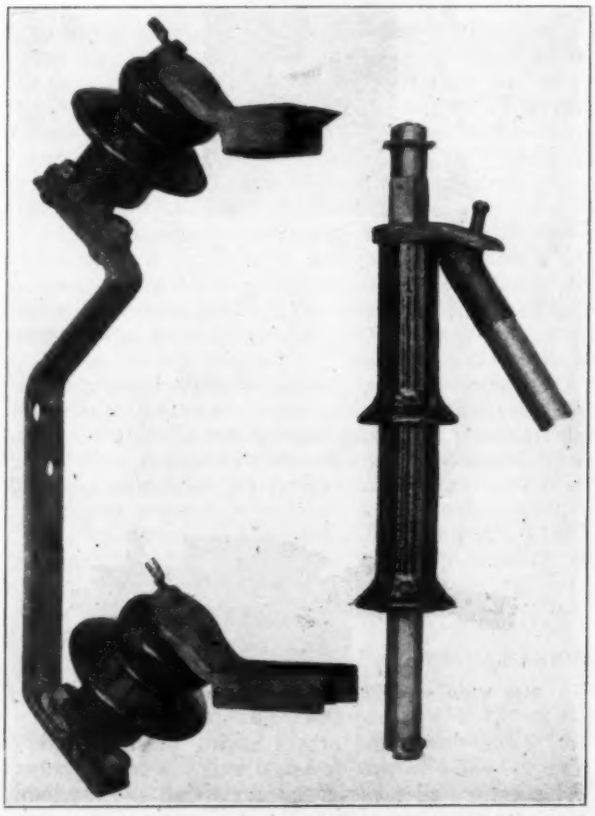
To close the circuit, the upper contact of the holder is placed in the upper clips by the operating hook and then the lower contact is pressed by the hook into the lower clips.

The supporting insulators are of the petticoat type.

The fuse holder has petticoats so spaced as to provide ample creepage surface. The contact parts at the ends of the fuse holder are of brass, and when the holder is in normal operating or closed position engage with the stationary contacts on the supporting insulators.

The contacts are protected against the effects of ice, sleet and snow by the method of mounting and by means of a punched hood attached to the top of each supporting insulator.

The fuse passes through the center of a treated fiber tube within the porcelain fuse holder and is attached to the upper or closed end of the fuse holder by means of an adjustable clamp, and to the lower or open end of the fuse holder by a circular ring which, when tightened, holds the fuse firmly in place without a tendency to shear off when the fuse blows. The explosion consequent upon the expansion of the gases formed effectively expels the arc through the open end of the holder downward and instantaneously opens the circuit. New fuses may be inserted readily.



15,000-Volt Expulsion Fuse Showing Method of Removing Holder From Supports.

This combined fuse and disconnecting switch, made by the General Electric Company, Schenectady, and known as the type TD-127, is made in single-pole units for vertical mounting on flat surfaces. It can be obtained for use at 15,000, 22,000, 35,000 and 45,000 volts.

The maximum current rating is 50 amperes.

No special arrangements are needed for mounting. The supporting bracket is bolted to the cross arm.

HIRSCHY ELECTRIC WASHER.

The Hirschy Company, Security Building, Minneapolis, Minn., has put on the market the Hirschy electric washer and wringer, an illustration of which is given herewith. Both washer and wringer may be operated at the same time. The washer is equipped with a "multi-motor," driving the machine through worm gears, which are entirely inclosed as a measure of safety; a belt pulley is provided so that the motor may be used to drive a churn, ice-cream freezer, or other machinery about the premises. The new type, three-position wringer, with 12-inch ball-bearing rolls, has tension springs for automatically adjusting them for thick or thin clothes, and has a release lever for

The Hirschy Electric Washer.

instantly unlocking the top roll. All the operating mechanism is underneath the tub.

Except for the tub, which is of seasoned cypress, the machine is made entirely of metal and has provision in the framework for telescoping metal benches to hold extra tubs and clothes basket. The outfit is very easily controlled, since there are only three levers, all conveniently placed, to govern the entire operation. Casters permit moving the machine about readily. The machine is liberally guaranteed. The Hirschy Company has put out most effective illustrated literature showing how the Hirschy electric washer "Gives Mother a Square Deal."

"TRIUMPH" ELECTRIC SEWING MACHINE.

The compact portable electric sewing machine has proved so popular that it will evidently largely supersede the foot-operated type in districts where electricity is available.

A new portable machine has just been placed on the market by the Triumph Specialty Company, 235 Canal Street, New York City. This machine consists of a sewing-machine head, a motor, a speed regulator and a cover. The whole outfit can be packed inside the cover, and is so light that it can be easily carried, and so compact that it can be put away in a closet. The machine, which can be used on any table, is always ready for operation when connected to any lamp socket.

The sewing-machine head is manufactured especially for the Triumph company, by the New Home Sewing Machine Company, and is an adaptation of one of the most popular models. It operates on the lock-stitch principle, and is provided with a full set of attachments for tucking, ruching, and other operations.

Power is supplied by a Westinghouse "Sew-Motor," which can be operated on direct-current circuits of 115 volts, and on alternating-current circuits of 110 volts of any frequency up to 70 cycles. The motor drives the machine through a belt and not by means of a friction pulley, thus assuring quiet operation and avoiding undue side thrust, which wears out the bearings. Occasional filling of the grease cups (oil is not used) is the only attention the motor requires.

The speed regulator which rests on the floor and which is operated by pressure of the foot, provides any speed from one to several hundred stitches per minute. It is so constructed that there is no sparking at the contacts and, being made of steel and heavily insulated, it is practically indestructible. A ten-foot well insulated and reinforced flexible cable with an attachment plug is provided for connecting the motor with the lamp socket.

The machine is handsomely finished in polished nickel and black enamel and is mounted on a Circassian walnut base with rubber feet to prevent marring the furniture on which it is placed. The cover is also of Circassian walnut.

WASHING-MACHINE MANUFACTURERS STANDARDIZE THEIR PRODUCTS.

The washing-machine manufacturers of the country have succeeded in putting into practice those methods of economy, required by the War Service Committee, for reducing the consumption of fuel, without lessening the volume of their products. These methods of economy in the use of coal, the reduction of operating costs, standardizing products, and keeping up the output, were outlined and discussed at the meeting of the American Washing Machine Manufacturers' Association, at Hotel Sherman, Chicago, recently.

One of the papers read at this meeting was by H. W. Eden, of the Brokaw-Eden Manufacturing Company, Alton, Ill., president of the association. After discussing the results of operating under the government fuel order, Mr. Eden set forth many interesting facts, from which we quote the following:

"The fear of drastic restrictions caused manufacturers not only to pledge themselves to the saving of certain percentages, but, over their own signatures, they agreed to eliminate 171 distinct styles and models of their product which might be considered as less essential and 63 parts of the styles and models which they will continue to produce. These eliminations make for standardization—the hardest thing in the world to accomplish in a competitive industry—mean lower costs and greater efficiency of production and a tendency towards an increase in volume of production. Such standardization benefits the entire industry—the manufacturer, the jobber, the retailer and the consumer."

The business done by washing-machine manufacturers during 1917 was approximately $10,000,000.

Current News

Weekly Record of Construction Activities—Conventions

EASTERN STATES.

HARTFORD, VT. — New England Telephone & Telegraph Company, 50 Oliver street, Boston, Mass., has had preliminary plans prepared for the construction of a two-story brick local telephone building, about 45x50 feet in size, at Gates and Currier streets, White Junction district, Hartford.

SPRINGFIELD, VT.—Colonial Power & Light Company has had plans prepared for the construction of an electric substation. The company has also contracted with the Cavendish Electric Light Company for supplying secondary power to the amount of 100 kilowatts to the plant of the Cavendish company.

WORCESTER, MASS.—W. H. Sawyer Lumber Company, 66 Lincoln street, has awarded a contract for the construction of a one-story power house, about 20x35 feet, at its plant. The structure, in connection with other buildings to be erected, will cost about $70,000.

BINGHAMTON, N. Y.—Binghamton Light, Heat & Power Company is rushing to completion the erection of its power house addition, two 600-horsepower boilers with stokers having been installed. It is expected that the new structure will be entirely completed within six weeks, and a 2000-kilowatt turbine will be installed. The company plans to have the power house in operation before the end of the summer.

BROOKLYN, N. Y.—Fire, on April 13, damaged the plant of Thompson & Bonney, 18-20 Benry street, manufacturers of electrical motor supplies, to the extent of about $5000.

LONG ISLAND CITY, N. Y.—A. J. Buschmann Company, 461 Eighth avenue, New York, has been awarded a contract for the electrical work in connection with the construction of an addition to the plant of the Welin Marine Equipment Company, 312 Vernon avenue, to cost $25,000.

COOPERSTOWN, N. Y.—Southern New York Power & Railway Company will issue $5,000,000 in bonds for extension and requiring new properties. Address local manager at Cooperstown.

GOWANDA, N. Y.—Georgia Light & Power Company has petitioned to operate an electric light system in the town of Dayton. Address George A. Larkin of Olean.

NEW YORK, N. Y.—The board of trustees of Bellevue and Allied Hospitals, 415 East Twenty-sixth street, has awarded a contract to Charles K. Daly, 172 Paynter street, Long Island City, for the construction of a power house at the local institution.

NEW YORK, N. Y.—Fred B. Zenker has leased property at 44 West Thirty-seventh street, where a general electrical repair and contracting establishment will be operated.

ROCHESTER, N. Y. — The City Board of Contract & Supply, has awarded a contract for the construction of a local power plant. The A. Friederich & Sons Company, 710 Lake avenue, Rochester, is the contractor.

SCHENECTADY, N. Y.—The Board of Education has had plans prepared for the construction of a three-story addition, about 85x95 feet in size to the Edison School in South Center street, to cost about $90,000.

BLOOMFIELD, N. J. — The town council is considering plans for improvements in the electric fire-alarm system.

BORDENTOWN, N. J.—The council has commenced work on the improvement of the electric lighting system for the city hall.

DOVER, N. J.—New Jersey Light & Power Company is making rapid progress in extensive improvement work at its plant, a new 3500-kilowatt turbine already having been placed on its foundations, and work is being rushed on the connection of the condenser. It is expected that the entire equipment will be ready for operation by May 1.

GLOUCESTER CITY, N. J.—The city council passed an ordinance granting permission to the Public Service Electric Company to install an electric conduit system in Market street from its local power house to King street.

NEWARK, N. J.—Until May 1, the Board of Freeholders will receive bids for the installation of a water-tube boiler in the boiler plant at the Essex County Hospital, Overbrook. Thomas W. Smith, chairman, Committee on Public Buildings.

NEWARK, N. J.—Northern Leather Works & Produce Company, Inc., 377 Broadway, New York, has had plans prepared for the construction of a large local power house at its plant on Backus street. Contract for construction has been awarded to H. W. Franklin, 110 Fort Green place, Brooklyn, N. Y.

OCEAN CITY, N. J.—Ocean City Electric Street Railway Company has been granted permission by the Board of Public Utility Commissioners to increase the rate of fare from five to seven cents.

OGDENSBURG, N. J.—Fire, on April 10, completely destroyed the power house of the New Jersey Zinc Company. Considerable machinery was also destroyed, including boilers, engines, several dynamos, compressers, and electric pumps. The total loss is estimated at $300,000.

TRENTON, N. J.—Crescent Insulated Wire & Cable Company, manufacturer of electrical wires, cables, etc., has commenced the construction of its proposed three-story factory building at Olden avenue and Taylor street. The structure is estimated to cost about $50,000. Barclay, White & Company, Philadelphia, are the contractors.

ALTOONA, PA.—Notice has been filed with the Public Service Commission by the Penn Central Light & Power Company of a bond issue for $75,000, to provide for extensions and improvements.

ALTOONA, PA.—Penn Central Power & Transmission Company has filed notice with the Public Service Commission of the issuance of bonds to the amount of $50,000, to provide for extensions, improvements, etc.

BROWNSTOWN, PA.—Brownstown Electric Light, Heat & Power Company has filed notice with the Public Service Commission of the issuance of bonds for $1000.

COATESVILLE, PA.—West Chester & Conestoga Traction Company is considering plans for the construction of a new traction line from the proposed terminus, commencing at the South City line on First avenue and extending to the iron and steel mills in the center of the town.

PHILADELPHIA, PA. — Philadelphia & Reading Railroad Company has had plans prepared for the construction of a one-story brick and concrete power house, about 45x75 feet, at Tulip and Somerset streets.

PHILADELPHIA, PA.—Philadelphia Hydroelectric Company, Manayunk Canal, has subscribed $20,000 to the Third Liberty Loan.

PHILADELPHIA, PA.—Plans are under consideration by the Philadelphia Electric Company and the Electric Bond & Share Company, 71 Broadway, New York, for extensive additions to the electric power stations at Harwood and other mining sections, to provide for increased capacity of approximately 100,000 horsepower. It is said that three new electric power plants having a capacity of 100,000 horsepower will be erected, and transmission lines constructed to connect the systems with the Public Service Electric Company, which operates in New Jersey and other lines in Delaware.

SHIPPENSBURG, PA.—Shippensburg Gas & Electric Company, operating in Cumberland and Franklin counties, has filed notice with the Public Service Commission of an increase in its rates for service.

STEELTON, PA.—Town council has recently completed improvements in the electric fire-alarm system.

WILMINGTON, DEL. — National Electric Appliance Company has filed notice with the Public Service Commission of a change in its corporate name to the Brokaw-Eden Manufacturing Company, and of an increase in its capital from $500,000 to $1,000,000 to provide for expansion.

WILMINGTON, DEL.—Fire, caused by an explosion, recently destroyed the turbine room at the plant of the Wilmington Gas Company, foot of Madison street, with loss estimated at $25,000.

BALTIMORE, MD. — Consolidated Gas, Electric Light & Power Company has awarded a contract for the construction of an addition to its substation to cost about $7000. The company has also recently contracted for the erection of a four-story boiler plant to cost $100,000.

NORFOLK, VA.—Virginia Railway & Power Company has awarded a contract to Nicholas & Linderman, Seaboard Bank building, Norfolk, for alterations and improvements in its one-story electric substation to cost $11,700.

RICHMOND, VA.—Williams Power Company has filed notice with the Public Service Commission of an increase in its capital from $50,000 to $150,000, to provide for extensions, improvements, etc.

WILLIAMSBURG, VA.—Williamsburg Power Company has increased its capital from $25,000 to $150,000.

PARKERSBURG, W. VA.—Parkersburg Iron & Steel Company is making rapid progress in the construction of a one-story power house addition at its plant, to cost about $12,000. The structure will be 30x45 feet.

BRANCHVILLE, S. C.—Preston Ott is in the market for a complete electric light plant.

OLDSMAR, FLA.—Oldsmar Electric & Ice Company has been organized to build an electric light and ice plant. Jacob Bornstein, president.

ST. PETERSBURG, FLA.—St. Petersburg Lighting Company is planning to increase the capacity of its local power plant by the installation of a 500-horsepower Heine type water-tube boiler and turbine-driven boiler feed pump.

BRUNSWICK, GA.—Georgia Coast & Piedmont Railway Company is in the market for six-horsepower electric motors. Address D. C. Smith, general manager.

COMMERCE, GA.—The city is considering a bond issue for $15,000 to provide for the construction of an electric lighting plant.

JEFFERSONVILLE, GA. — The council will improve the electric light system. Address J. G. Rockmore, mayor.

NORTH CENTRAL STATES.

COVINGTON, OHIO. — Buckeye Light & Power Company has increased its capital from $40,000 to $60,000.

ST. PARIS, OHIO.—The sum of $5500 in bonds has been voted to improve the electric light plant. Address Harry D. Barley, village clerk.

INDIANAPOLIS, IND.—Merchants' Light & Heat Company has increased its capital stock from $2,000,000 to $2,500,000.

INDIANAPOLIS, IND. — Indiana Public Service Commission has authorized the Interstate Public Service Company to issue $45,087.73 in bonds to pay for improvements made out of funds temporarily borrowed. The bonds are to be sold for not less than 80 per cent of par. The commission also authorized this company to issue $7200 in bonds at par. The company has made improvements at Shelbyville, Crown Point, Lowell, Lebanon, Monticello, Kentland, Fowler, Newcastle, Bedford, Corydon, Seymour, Greenfield and Salem.

RICHMOND, IND.—Kilo Electric Meter Company, formerly of Indianapolis, will locate in Richmond. The plant of the company in Indianapolis was destroyed by fire some time ago.

GILLESPIE, ILL. — The Illinois Traction System has secured the contract for supplying power for a new coal mine being sunk here. The traction company will also transport the coal mined from the new shaft.

MATTOON, ILL.—The Illinois Public Utilities Commission has suspended until August 28 the proposed six-cent street car fare asked by the Central Illinois Public Service Company in Taylorville, Ill.

SPRINGFIELD, ILL.—The Illinois Supreme court has held that the State Public Utilities Commission has exceeded its authority when it directed the Postal Telegraph Company to cease operating a telephone service out of Chicago. The order of the commission, the court held, was in the nature of an injunction, which the supreme court holds that only a court has authority to issue.

SPRINGFIELD, ILL.—The Illinois supreme court has ruled that the expenses for transcript of evidence covering orders of the Illinois Public Utilities Commission must be paid for by the Commission. The decision was the result of a suit in the Sangamon county circuit court involving a petition of the DeKalb County Telephone Company. The new ruling will cost the Commission thousands of dollars.

SYCAMORE, ILL. — Woodstock-Sycamore Interurban Company, which was organized ten years ago and which has had an electric line in operation between Sycamore and Marengo for eight years, has dissolved and the rails, ties and equipment are being sold as junk. The road was originally planned to run from Sycamore to Woodstock, but only the portion between Sycamore and Marengo, 20 miles, has ever been constructed. The company has never earned enough to pay its operating expenses and dividends.

TUSCOLA, ILL.—Board of Education will build a $33,000 heating plant and gymnasium, with electric wiring and lights, as an addition to the high school building.

BURLINGTON, IOWA. — Home Electric Company has filed a notice of dissolution.

DUBUQUE, IOWA.—Chicago, Milwaukee & St. Paul Railway will expend $50,000 at its power plant and railway shops. Electrical equipment will be installed. Address the local superintendent.

GARDEN CITY, MO.—Green Light & Power Company, of Pleasant Hill, Mo., is reported to have purchased the local electric light system and will construct a transmission line from Pleasant Hill to Garden City.

OZARK, MO.—Ozark Coal & Mining Company will expend $6000 for installing additional electric coal mining

DATES AHEAD.

National Fire Protection Association. Annual meeting, Chicago, Ill., May 7-9. Secretary, Franklin H. Wentworth, 87 Milk street, Boston, Mass.

National Electrical Supply Jobbers' Association. Annual meeting, May 6, 7 and 8, Del Monte, Cal.

Pacific Coast Section of National Electric Light Association and California Association Electrical Contractors and Dealers. Joint convention, May 9, 10 and 11, Del Monte, Cal.

American Association of Engineers. Annual meeting, May 14, 1918. Secretary-Treasurer, A. H. Krom, 29 South La Salle street, Chicago.

Arkansas Association of Public Utility Operators. Annual convention, Arlington Hotel, Hot Springs, Ark., May 21-22-23. Secretary-Treasurer, R. B. Fowles, Pine Bluff, Ark.

Electrical Supply Jobbers' Association. Annual meeting, Homestead Hotel, Hot Springs, Va., May 21-22-23. Secretary, Franklin Overbaugh, 411 South Clinton street, Chicago.

Electrical Contractors' Association of Georgia. Annual meeting, Tybee Island, Ga., June, 1918. Secretary, Dan Carey, 614 Chamber of Commerce building, Atlanta, Ga.

American Society of Mechanical Engineers. Spring meeting, Worcester, Mass., June 4-7. Secretary, Calvin W. Rice, 29 West 39th street, New York City.

National Electric Light Association. Annual convention, Hotel Traymore, Atlantic City, N. J., June 13 and 14. Secretary, T. C. Martin, 33 W. 39th street, New York City.

Texas State Association of Electrical Contractors. Annual meeting, Galveston, Tex., June 15, 1918. Secretary, H. S. Ashley, Fort Worth, Tex.

Southeastern Section, National Electric Light Association. Annual meeting, June 19-20, 1918. Atlanta, Ga. Secretary-Treasurer, T. W. Peters, Columbus, Ga.

American Institute of Chemical Engineers. Summer meeting, Berlin, N. H., June 19-22. Headquarters, Mt. Madison House, Gorham, N. H. Secretary, John C. Olsen, Brooklyn, N. Y.

American Institute of Electrical Engineers. Annual convention, Atlantic City, N. J., June 26-28. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

Ohio Electric Light Association. Annual meeting, Cedar Point, Ohio, July 10-12. Secretary, D. L. Gaskill, Greenville, Ohio.

National Association of Electrical Contractors and Dealers. Annual convention, Cleveland, Ohio, July 17-20. Secretary, Harry C. Brown, 101 West 40th street, New York City.

Northwest Electric Light and Power Association; affiliated with N. E. L. A. Annual meeting, September 11, 1918. Secretary, George L. Myers, Pacific Power & Light Company, Portland, Ore.

machinery. Address N. V. Waterfield, secretary.

MANHATTAN, KANS.—Manhattan City & Interurban Company, operating a city street car service and interurban service between that city and Fort Riley, Camp Funston and Junction City, announces that it will rehabilitate its tracks and overhaul all equipment.

PITTSBURG, KANS. — Joplin & Pittsburg Railway Company has granted an increase of three cents an hour to all persons in its employ.

SHERMAN, S. D. — Bim Brothers have been granted a franchise for furnishing electric light.

VERMILION, S. DAK.—The council is planning to issue $20,000 in bonds for an electric light plant. Address village clerk.

SOUTH CENTRAL STATES.

ALEXANDER CITY, ALA.—Bonds to the amount of $10,000 have been voted to improve the electric light plant. Address the mayor.

ENSLEY, ALA.—Southern Bell Telephone Company is planning for the construction of an addition to its local telephone building on Nineteenth street, between F and G streets. Estimated cost of the work is $17,250.

HUNTSVILLE, ALA.—Miller Brothers are considering plans for the reconstruction of their electric power cotton gin recently destroyed by fire.

PURVIS, MISS.—The city is planning for a bond issue of $10,000 to provide for the construction of an electric light plant to have a capacity of 30 horsepower.

RECTOR, ARK.—In connection with the construction of a gin house and cotton house, Luther King has had plans prepared for the construction of a new power house for works operation.

GOTEBO, OKLA.—The city will rebuild its electric light plant, recently destroyed by fire.

PRAGUE, OKLA.—The city has authorized a bond issue for $30,000 to provide for improvements in the electric lighting plant and water works.

RYAN, OKLA.—City contemplates the installation of a crude-oil engine in the electric light and water plant. Address the mayor.

STILLWATER, OKLA.—City has had plans prepared for improvements to the electric light system, the cost of which is estimated at $30,000.

BEAUMONT, TEX.—Kansas City Southern Railroad will install electric power on its drawbridge across the Neches river at this point, and make other improvements which will mean much less time lost to passing ships.

CARTHAGE, TEX. — An electric light and ice plant will be installed by F. T. Rembert of Longview, Tex.

CLYDE, TEX.—Robert Cook will construct an electric light and power plant here.

DENISON, TEX.—City contemplates the installation of an electric light plant.

ROUND ROCK, TEXAS.—S. E. Bergstrom of Kerns, Texas, will construct an electric light and power plant here.

RIO GRANDE CITY, TEX. — Rio Grande Ice, Water & Light Company has filed notice of an increase in its capital of $24,000 to $30,000 to provide for improvements.

TEXAS CITY, TEX.—Texas City Electric Light & Water Company is considering plans for the construction of an electric power station and the installation of a 100-kilowatt turbogenerator with converter, to be used as a street railway and emergency lighting unit.

WESTERN STATES.

RONANA, MONT.—A. H. Stevens, president of the Flathead Independent Telephone Company, has perfected plans for the further development of the rural telephone service. This place is to be the central station for the following towns: St. Ignatius, Leona, D'Aste, Horte and others.

CENTRALIA, WASH.—City commission has awarded a contract to the Devore Electrical Company for furnishing street lamps.

SEATTLE, WASH.—Puget Sound Traction, Light & Power Company, 860 Stuart building, has permit to erect an addition to power house at 6600 14th street, South, cost about $30,000. Stone & Webster builders.

SEATTLE, WASH.—D. W. Rutherford of Tacoma has submitted low bid for construction of the first section of the municipal elevated street railway line to the shipyards. The first contract will cover the piling and trestle for the section of the line from Holgate avenue to Washington street on Railroad avenue and the Rutherford bid is $42,262.

PORTLAND, ORE.—To finance the Northwestern Electric Company's steam auxiliary power plant here which is estimated to cost $1,500,000, an issue of first mortgage six per cent bonds maturing May 1, 1935, has been sold at the San Francisco headquarters of E. H. Rollins & Sons at 95 and accrued interest.

REDDING, CAL.—The question of issuing $40,000 in bonds for the municipal electric light plant will be submitted to a vote of the people. Address city clerk.

PROPOSALS

MATERIAL FOR HEATING SYSTEM.—Bids will be received at the office of Indian Affairs, Department of Interior, Washington, D. C., until April 30 for furnishing materials and labor for the installation of a heating system at Shawnee, Okla.

POWER HOUSE.—Bids will be received on April 30 for the construction of a power house for the Electric Light & Water Company. Address R. F. Legar, attorney.

ELECTRICAL SUPPLIES. — Bids will be received at the office of the General Purchasing Officer, Panama Canal, Washington, D. C., until May 2 for furnishing, free of all charge, by steamer, on dock at either Colon (Atlantic port) or port of Ancon (Balboa, Canal Zone) (Pacific port), Isthmus of Panama, the following electrical supplies: Transformers, electrical switches, testing blocks, marine brackets, carbon brushes, condulets, connectors, cutouts, marine fixtures, plugs, rosettes and steel and copper wire.

INCORPORATIONS

NEW YORK, N. Y.—Conlan Electric Corporation. Capital, $10,000. To manufacture electrical supplies. Incorporators: D. Conlan, Jr., F. A. Butler, and R. S. Conlan, 2120 Harrison avenue.

NEW YORK, N. Y.—Metalloy Company. Capital, $5000. To manufacture electric and gas fixtures. Incorporators: A. Blau, B. Zeiner, and H. S. Burger, 907 Columbus avenue.

CHATTANOOGA, TENN.—Southern Cities Power Company has incorporated with a capital of $50,000. George B. Adams, J. C. Stickney, G. W. Erwin and others are the incorporators.

NEW YORK, N. Y.—Tirrell Manufacturing Company was recently incorporated to manufacture electric light controllers and lighting apparatus. The incorporators are: C. L. Rimminger, M. M. Clancy and F. A. Armstrong.

WILLIAMSPORT, PA.—Appliance Sales Company. Capital, $9,000. To manufacture electrical appliances. J. P. Haag is the principal incorporator.

WAYLAND, N. Y.—Wayland Light & Power Company, Inc. Capital, $100,000. To operate a plant for the generation and distribution of electricity. Incorporators: V. M., J. and L. F. Kimmel, Wayland.

INDIANAPOLIS, IND. — International Electrical Company has been incorporated with capital of $20,000 to engage in the manufacture of electric machinery. The directors will be Gordon B. Tanner, Fred Sterling, Jr., and M. H. Tanner.

HARRISON, ARK.—Harrison Gas & Electric Company has incorporated for the purpose of extending the electric light system. Address R. M. Fellows, president.

FORT WAYNE, IND.—Dix-Kelly Electric Shop has been incorporated with capital of $10,000. The directors are Frank J. Dix, E. Kelly and Robert E. Kelly.

JOHNSTOWN, PA.—Grazier Electrical Products Company. Capital, $40,000. To manufacture electrical supplies. J. S. Grazier is the principal incorporator.

UTICA, N. Y.—Held Electric Company. Capital, $5000. To manufacture electrical supplies. Incorporators: H. L. and J. P. Held, Utica.

NIXON, TEX.—Nixon Electric Light & Power Company has been incorporated here with a capital stock of $12,000 for the purpose of constructing an electric light and power plant. J. F. Wood is a stockholder.

CHELAN, WASH.—Chelan Falls Power Company has been incorporated for $150,000 by George D. and Amelia M. Brown and R. C. Kennedy.

Trade Activities

Western Electric To Open Spokane Branch—Phoenix Electric Occupies New Quarters—Valuable Catalogs Distributed

The Pittsburgh Service Station for Westinghouse automotive electric equipment has been moved to 6905 Susquehanna street, Pittsburgh, Pa., in the Homewood district.

Walter A. Zelnicker Supply Company, 325 Locust street, St. Louis, Mo., is distributing bulletin No. 236, which describes in a brief and condensed form a portion of its line of rails, locomotives, cars, machinery, wire rope, compressors, pipe, tanks, etc.

Splitdorf Electrical Company, Newark, N. J., which last fall decided to concentrate on ignition apparatus and cease to manufacture starting and lighting sets save for repair purposes, has sold its Apelco battery assets to the H. B. Shontz Company, of New York City. The latter firm will continue the manufacture of Apelco storage battery for all purposes, as well as supply repair parts, and has taken over the entire Apelco stock of the Splitdorf Company.

Westinghouse Lamp Company, 165 Broadway, New York, N. Y., is distributing a circular, calling attention to the change in the Westinghouse Mazda lamp carton. The new carton is of a bold poster design, with broad bands of orange and black, and will enable lamp users to distinguish more readily this Westinghouse product. It will be found a unit of great adaptability to the distributor in designing attractive window displays.

Phoenix Electric Company, Mansfield, Ohio, manufacturer of alternating-current motors, recently moved into a new modern, two-story building, which was fully equipped for this class of manufacturing. The company's increase in business and plans for expansion made necessary these larger quarters. This company is controlled by A. C. Linzee, formerly designing engineer for the General Electric Company at Akron, who has developed a line of alternating-current motors which are proving a great success, and which are to be manufactured on a larger scale at the new plant.

The Wheeler Condenser & Engineering Company, Carteret, N. J., has just published its Bulletin No. 108-B, embracing exclusively its line of centrifugal pumps. The bulletin shows the latest Wheeler turbine-driven geared centrifugal pumps, bi-rotor, tri-rotor, electric-driven, small belt-driven, small high speed, side, end and bottom suction vertical shaft; pumps for either series or parallel operation; and special slow-speed engine-driven pumps. Test curves made by both manufacturer and customer are included in the bulletin, giving the characteristics of Wheeler high grade design. Wheeler pumps are made for all services and especially for installations where large volumes of water must be pumped economically against low heads.

The United States Rubber Company—Wire Division, 524 First avenue South, Seattle, Wash., has supplied the Pacific States Electric Company, a Seattle concern, with a $15,000 wire order for use in 20 wooden ships under construction in the Sloan shipyards at Olympia, Wash.

Pass & Seymour, Inc., Syracuse, N. Y., has sent out leaflets describing the P&S pull canopy fixture switches. These are arranged to fit into the canopy and serve as a ceiling switch for pendent and drop-cord work. The construction of the device is well explained and it is believed that it will meet a large demand.

Wagner Electric Company, Seattle, Wash., has moved its offices from 506 Pacific building to 538 First avenue, South, where new quarters have been fitted up and a complete service bureau established. The company has witnessed a great increase in its business and this has necessitated larger and better equipped offices. Much business is now being transacted with the shipyards. C. Kirk Hillman has charge of the offices.

Western Electric Company, 195 Broadway, New York City, will open a branch at Spokane, Wash., about May 1 in the building formerly occupied by the Pacific States Telephone Company at 165 Howard street. The western third of Montana, northern half of Idaho and eastern Washington will be covered from the Spokane office. The business is to be wholesale only, and a stock valued at $100,000 will be installed. This is the most recent unit to be established, the company operating 35 other houses in different parts of the United States and Europe.

Universal Electric Stage Lighting Company, 240 West 50th street, New York, has issued a catalog dealing with stage and studio lighting apparatus and electric effects. It illustrates and describes the many new developments in stage lighting and effects, which have been recently introduced. The popularity and remarkable present day success of many theater productions, dramas, and particularly musical comedies, are largely attributed to the modern developments of stage lighting. Among the accessories shown are the well known Kliegl spot lights, electric effects, pockets and plugs, connectors, border lights, proscenium lights, disappearing foot lights, act announcers, fire logs, reflectors, electric carriage calls and Klieglight and Lilliput arc lamps, with accessories, for motion picture photography. The aim of this concern has been to make each article, bearing its trade name, Kliegl Brothers, to be the best of its kind and for its purpose, and the apparatus is claimed to be practically a standard on the American stage. Copies of this catalog will be sent free to anyone interested upon request.

Ross Power Equipment Company, Indianapolis, Ind., is distributing Bulletin 67, which supersedes all previous lists. The list includes an extensive line of power plant equipment, all of which is offered subject to prior sale.

National Pole Company, Escanaba, Mich., will open an office at 220 Broadway, New York, on May 1, with R. A. Griffin in charge as general sales manager. Mr. Griffin has been at the head of the pole department of the Western Electric Company for a number of years, and prior to that time was purchasing agent for the American Telephone & Telegraph Company.

Byron-Powell Company, Spokane, Wash., a recently organized electrical engineering firm, has opened offices at S167 Wall street, with J. P. Byron, formerly connected with the Washington Water Power Company, Spokane, Wash., as head of the organization. The new company will engage in a general electrical engineering business, handling equipment of all kinds, and will also conduct a general repair business.

Binder Elevator & Electrical Company, Birmingham, Ala., has removed its offices from the plant and warehouse located at 209-211 Twenty-second street, to 305 Twentieth street, North, where a new store has been opened. All the office work for the plant, retail establishment and construction department will be handled at the new address. The old building will be devoted exclusively to electrical repairing, motor and elevator work.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announces the merger of the Copeman Electric Stove Company into a new company to be known as the Westinghouse Electric Products Company, with headquarters and factory at Mansfield, Ohio. This factory will be devoted to the manufacture of heating appliances, previously made at the Newark works of the electric company and the Flint (Mich.) works of the Copeman Electric Stove Company. The general operation of the Westinghouse Electric Products Company will be directed by W. K. Dunlap, as general manager. Mr. Dunlap is also assistant to the vice-president of the Westinghouse Electric & Manufacturing Company.

The Westinghouse Electric & Manufacturing Company has just issued a special publication (Circular No. 7174), entitled "Electrical Equipment for Cement Mills." This pamphlet has an attractive art cover, illustrating the interior of a motor-driven cement mill. Numerous photographic reproductions are given through the publication, showing the application of motors to various types of machinery employed in cement mills. The advantage of motor drive for this class of service, and characteristics required by motors to be especially successful are given briefly.

Latest Approved Fittings

The electrical fittings listed and described in this department have been approved by the Underwriters' Laboratories, Incorporated, after examination and tests conducted under standards of the National Electrical Code as recommended by the National Fire Protection Association.

Attachment Plugs, Fuseless.—Mueller Electric Company, 423 High avenue, Cleveland, Ohio.

Non-separable attachment plugs, consisting of single-piece body of porcelain or standard insulating material and Edison screw shell.

"Attacho Plug," 660 watts, 250 volts, catalog No. 4.

Listed March 6, 1918.

Clocks, Motor-Driven. — Warren Clock Company, Ashland, Mass.

Stationary and portable clocks driven by small synchronous motors from alternating-current systems, frequency of which is regulated by means of special instruments installed at supply station. Rating 110 volts, 2 watts.

Listed January 25, 1918.

Fixtures.—A. C. Penn, Inc., 100 Lafayette street, New York, N. Y.

"The Wallace Lamp." Adjustable fixture consisting of standard socket, secured to hinged nipple mounted upon base provided with mounting clamp. Provided with portable cord, standard attachment plug and shade designed to clamp on incandescent lamp bulb.

Listed March 1, 1918.

Fuses, Plug. — Chelten Electric Company, 314 Armat street, Philadelphia, Pa.

"Chelten-Phila" Edison plug fuses, having horn fiber for insulation of live parts and of brass-rimmed mica cap. 0-30 amperes, 125 volts.

Listed March 19, 1918.

Ground Clamps. — Hessco Electric Manufacturing Company, 210 Adelaide street, West, Toronto, Ont.

"Hemco" ground clamps for use with ½ and 1½-inch rigid conduit. Catalog No. 346.

Listed March 21, 1918.

Optical Instruments.—F. A. Hardy & Company, 10 South Wabash avenue, Chicago, Ill.

Potential reducer for Worth-Black amblyoscope optical instruments, consisting of line resistance connected in series by flexible cords to pair of miniature lamps mounted in metal inclosures, each containing adjustable lamp-dimming rheostat. 5 amperes, 110 volts.

Listed February 13, 1918.

Portable Air Pump.—Mayo Skinner Manufacturing Company, 2115 Elston avenue, Chicago, Ill.

"Mayo." This device consists of two-cylinder air compressor driven by small motor with chain transmission, and controlled by snap switch, all mounted on portable truck. For use primarily in pumping automobile tires. ¼ horsepower, 110-220 volts, alternating or direct current.

Listed March 8, 1918.

Protectors.—Reliable Electric Company, 411 South Sangamon street, Chicago, Ill.

Consist of carbon lightning arresters with inclosed cartridge fuses, mounted on porcelain bases, for use on signal circuits. With metal-inclosed arresters, catalog No. 976.

Listed February 26, 1918.

Receptacles, Medium-Base.—Thomas Cusack Company, Harrison and Loomis streets, Chicago, Ill.

"De Luxe No. 22" sign receptacle.

Listed March 21, 1918.

Recorder, Electrically Operated.—Production Meter Company, 2909 Indiana avenue, Chicago, Ill.

"The Production Meter." Production recorder, consisting of chart inclosed in cabinet and marked by individual styluses controlled by unit mechanisms electrically connected, together with electrically operated counters, to control switches mounted on machines whose output is being measured, and energized by low-voltage motor-generator. Generator rating: 20 volts, 15 amperes; motor: 125 volts.

Listed February 12, 1918.

Supports for Outlet Boxes.—Ohio Distributing Company, 220 Lomax Place, Chicago, Ill.

Supports consisting of strap iron bars and clamps. Bars have numerous perforations for mounting on joists, etc., and may be straight or furnished with an offset portion. Clamps provided with bolts for attaching outlet boxes, etc. Designed for use in hollow walls or ceilings. "O. D."

Listed February 12, 1918.

Subbases, Surface Snap-Switch.—The Arrow Electric Company, Hartford, Conn.

"Arrow E" porcelain subbases for mounting surface snap switches. Catalog Nos. 6674, 6676, 6678.

Listed February 9, 1918.

Switches, Automatic Clock-Operated Type.—W. N. Matthews & Brother, Inc., 3722 Forest Park boulevard, St. Louis, Mo.

Automatic switch consisting of clock mechanism, connecting gear and standard labeled snap switch, all inclosed in wood case and designed to open and close circuits at predetermined periods. "Matthews Horoswitch," 30 amperes, 250 volts.

Listed March 15, 1918.

Switches, Inclosed. — The Johns-Pratt Company, Hartford, Conn.

Watertight service-entrance boxes inclosing cutout bases for standard cartridge inclosed fuses. Covers of boxes fitted with attachments whereby opening of boxes may cause the fuses to be withdrawn.

"Noark," 0-600 amperes, 600 volts, catalog No. 5770 to 5777 inclusive.

Listed February 6, 1918.

Switches, Inclosed.—Meyers Electric Safety Switch Company, 1236 Mission street, San Francisco, Cal.

Fused knife switch inclosed in sheet-metal cutout box, to deeply flanged door of which knife blades are attached and by means of which switch may be operated externally without opening inclosure. 250 volts, 30, 60, 100 amperes. Type A.

Listed February 12, 1918.

Switches, Fixture. — The Bryant Electric Company, Bridgeport, Conn.

Candle, push-button, catalog No. 96.

Caps, AA-AH inclusive, AK-AN inclusive, AP, AR, AS, WA-WC inclusive, WK-WN inclusive, WP, WR, WS, WT.

Also combinations of above caps and bodies.

Listed January 30, 1918.

Switches, Knife.—Meyers Electric Safety Switch Company, 1236 Mission street, San Francisco, Cal.

Service-entrance switch and cutout base inclosed in sheet-metal cutout box on door of which knife blades are mounted. Operated by opening and closing door of case. 250 volts, 30 amperes. Type B.

Listed February 13, 1918.

Switches, Knife.—Mutual Electric & Machine Company, 232 West Fort street, Detroit, Mich.

"Type C," 30 and 60 amperes, 250 and 600 volts.

Listed February 21, 1918.

Switches, Surface. — The Bryant Electric Company, Bridgeport, Conn.

"Bryant" or "Perkins." Two-circuit. Catalog No. 2662-Special.

Listed January 31, 1918.

Transformers, Lighting.—Imperial Electric Company, Union City, Ind.

Air-cooled autotransformers with regulating rheostat and meter designed to supply current for 20-ampere, 30-volt, gas-filled incandescent lamps for stereopticon use. 60 cycles; primary 110 volts, secondary 30 volts, 20 amperes continuous; 40 amperes intermittently.

Listed March 15, 1918.

Wire Connector.—Mutual Electric & Machine Company, West Fort street and Fourth avenue, Detroit, Mich.

"Mutual" soldering lugs stamped and drawn from solid, cylindrical rod of electrolytic copper. 60, 100, 200 amperes.

Listed February 12, 1918.

Men in Service

W. H. Merrill Chairman Fire Prevention Section of War Board—C. R. Dooley Directs Vocational Education Project

ALBERT SCHLORFF, formerly with the Springfield Utilities Company, now in government service at Kelley Field, Texas, has been commissioned a first lieutenant.

ELECTRICAL SUPPLY JOBBERS' ASSOCIATION, 411 South Clinton street, Chicago, now carries on its roll of honor the names of 1643 members serving in the army and navy.

F. A. MCCONNELL, formerly in the engineering department of the Mountain States Telephone & Telegraph Company was recently commissioned a lieutenant and is now on duty in Washington, D. C.

SOUTH-EASTERN UNDERWRITERS' ASSOCIATION records the following names of its electrical engineering members who have entered government service: H. N. Pye, a second lieutenant in the ground corps of the aviation service; J. M. Bradfield, Norman F. Pratt, and E. H. Carman, first lieutenants in the Officers Engineers Reserve Corps, and J. L. Orr, serving with the Naval Reserve.

GEORGE F. SEVER, formerly professor of electrical engineering and acting dean of the faculty of applied science at Columbia University, was recently commissioned a major in the Engineer Officers' Reserve Corps with headquarters at Washington, D. C. Major Sever was for more than 12 years consulting electrical engineer for the Department of Water Supply, Gas & Electricity for the City of New York. He has closed his engineering office in New York.

C. R. DOOLEY, manager of the educational department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been granted a leave of absence as to accept an appointment by the government as director of the Vocational Education Project for Army needs, now being developed by the War Department Committee on Educational and Special Training. He will be located in the War Department at Washington, D. C. This appointment comes as a direct recognition of Mr. Dooley's ability as a practical educator and organizer of men, and is not the first time he has been summoned to the aid of the government. With the assembling of the first drafted men at Camp Sherman, Mr. Dooley was given the task of instituting and putting into operation a system of classification, by which it is possible, in a few minutes to select from the men in the cantonment the one best fitted for any particular class of service. The efficient manner in which this system was installed is largely responsible for Mr. Dooley's second call from the government. During Mr. Dooley's absence from the Westinghouse company, his duties there will be assumed by C. S. Coler, who has been appointed acting manager of the educational department.

ROLL OF HONOR.

The electrical industry, perhaps to a greater extent than any other industry, has answered the call of the Nation for Men. As this is a war of engineers, naturally the technically trained men in the electrical industry have been in great demand and they have responded with splendid patriotism. Many of the large utility and industrial corporations have assigned men for Government service aside from those who have voluntarily entered or been called for service.

THE ELECTRICAL REVIEW *will welcome news concerning men who have entered the service or who are engaged in any patriotic duties.*

WILLIAM H. MERRILL, president of Underwriters' Laboratories, Chicago, has been appointed section committee chairman of the newly organized Fire Prevention Section of the War Industries Board of the Council of National Defense. Mr. Merrill is now in Washington to assume the duties of the new position for the period of the war. Part of the work of the new section is the securing of information on the conditions as to fire hazards existing in plants manufacturing munitions and providing adequate protection where surveys show plants working on government contracts to be poorly guarded against possible fire loss. State fire marshals, municipal fire prevention bureaus, insurance boards, bureaus, associations, companies, in fact all existing fire prevention organizations, are being enlisted by the section in a co-operative effort to avoid interference of government's program through fires in munitions plants and government establishments. That duplication of effort by inspectors or others having a common errand in building and plants may be prevented, the matter of licenses or permits to inspectors, engineers and others to enter government and munition plants for the purpose of inspection of fire hazard conditions will be handled by the Fire Prevention Section.

William H. Merrill.

Mr. Merrill brings to the Fire Prevention Section the experience in fire prevention engineering gained during a period of 25 years of active participation in nation-wide fire prevention work. He began his career as an electrical inspector in Boston and Chicago and later worked out the idea and organization of Underwriters' Laboratories established and now maintained for service—not profit, by the National Board of Fire Underwriters. The steady growth and valued service of the Laboratories demonstrates the executive ability which Mr. Merrill brings to the new section created to aid in winning the war.

PACIFIC POWER & LIGHT COMPANY, Portland, Ore., in the April number of its bulletin, publishes its roll of honor, bearing the names of 36 employes who have gone into active service with the military or naval establishments of the government. The list shows the name, position held with the company, military organization and present address of those enlisted where available.

CLARENCE FLOYD HIRSHFIELD, head of the research department of the Detroit Edison Company, Detroit, Mich., was recently commissioned a major in the Ordnance Department, Washington, D. C. Early in 1915 Major Hirshfield left the Cornell University, where he had been a member of the engineering faculty, to go to Detroit to devote a considerable portion of his time in studying problems of electrical industrial heating.

UNIVERSITY OF MICHIGAN, Ann Arbor, Mich., honor roll includes the following names of electrical engineering students and graduates of that institution now in military service: William B. Boice, Willis Brodhead, James S. Brusstar, Arvine N. Clarke, Clarence T. Fishleigh, Henry W. Gilmore, Lee D. Handy, Paul W. Hoag, Claude B. Keeney, Lyle W. Kennedy, Franklin Loucks, Aaron Woodrooffe Manby, John W. McDonald, Douglas C. Mittelsdorf, Robert C. Parks, Warren L. Porter, John E. Powell, Adrian C. Roosenraad, Leon A. Sears, Frederick A. Sellke, Richard D. Smith, Charles E. Toole, George M. Unsworth, Francis C. Warren and William F. Wetmore. A. H. Lovell and H. S. Sheppard, associate professors, and W. F. Davidson, an instructor in the College of Engineering, are among those serving with the colors.

Personal

F. V. Burton and J. C. Rockwell Promoted—W. L. Smith Elected Professor Northeastern College—Other Changes

CHARLES H. SESSION of Topeka, Kans., has been appointed a member of the Kansas Public Utilities Commission by Governor Capper.

E. C. PFENNING, secretary of the City Light & Traction Company, Sedalia, Mo., has been transferred to a similar position with the Montgomery Light & Water Power Company, Montgomery, Ala. Allen O'Nannon, general bookkeeper at Sedalia, succeeds Mr. Pfenning.

THOMAS F. MURPHINE has been appointed by Mayor Hanson as superintendent of public utilities for Seattle, and succeeds A. L. Valentine who has held the position for nine years. Mr. Murphine, who is an attorney has attained some prominence in the politics of the section and resigns as attorney general of the state to accept the position.

WILLIAM B. VOTH, formerly manager of the Ogdensburg Power, Light, Street Railway & Gas Company, Ogdensburg, N. Y., has become district manager of the Wisconsin-Minnesota Light & Power Company, Eau Claire, Wis., succeeding A. R. Manley who resigned. Mr. Voth before going to Ogdensburg was chief engineer and purchasing agent of the Empire United Railways. He was born in Milwaukee and educated in the schools of that city and at the University of Wisconsin. After his graduation from the latter institution he entered the field of electric and steam railroad construction and later engaged in the operating work of public utilities.

WILLIAM LINCOLN SMITH, secretary and treasurer of the National Association of Electrical Inspectors since March, 1911, and inspector of wires for the city of Concord, Mass., has been elected professor of electrical engineering of Northeastern College, Boston, Mass. He is a graduate of the Massachusetts Institute of Technology and has taken keen interest for a great many years in electrical inspection and the improvement of electrical construction. He was secretary of the Municipal Inspectors' Association of Massachusetts many years ago, and is now a corresponding member of the Electrical Council of Underwriters' Laboratories, Inc. Professor Smith has been conducting electrical work at Northeastern College as an instructor for some time without interfering with his relations with the National Association of Electrical Inspectors and the city of Concord, and will continue to do so in his higher position. Northeastern College is conducted by the Boston Young Men's Christian Association as its educational department and includes among its five schools the Co-operative School of Engineering and the Evening School of Engineering. It is with these two schools that Professor Smith is directly connected as head of the electrical engineering department.

FRANK V. BURTON, for many years associated with the Bryant Electric Company, Bridgeport, Conn., in various capacities, was recently promoted to the position of general sales manager of the company. Mr. Burton was educated in the public schools of his native city, Albany, N. Y., and in 1891, at the age of 17, in partnership with his brother, engaged in the electrical contracting business. This enterprise, which was operated with variable success, terminated in three years. He entered the electrical contracting firm of Berger, Rogers & Potter of Troy, N. Y. In 1895 Mr. Burton entered the employ of the Western Electric Company at

Frank V. Burton.

New York, first in the construction department, and later in the supply department, where he remained for over six years. A short connection with the electrical engineering firm of Sanderson & Porter of New York followed, and in the summer of 1902 he entered the employ of the Bryant Electric Company, with whom he has since remained. He first held the position of service correspondent, in 1907 became eastern sales manager, and now general sales manager. He is an associate of the American Institute of Electrical Engineers, a member of the Jovian Order, and is active in several sections of the Associated Manufacturers of Electrical Supplies.

B. H. GLOVER, associate electrical engineer of the Underwriters' Laboratories, Chicago, has been temporarily assigned to work at the Bureau of Standards, Washington, D. C.

U. N. BETHELL, president of the New York Telephone Company, New York, has been appointed chairman of the Public Utility Committee of the Liberty Loan, succeeding George B. Cortelyou, president of the Consolidated Gas Company, who acted in that capacity during the Second Liberty Loan Campaign.

C. L. PROCTOR, who has been new business manager of the Empire District Electric Company, with headquarters at Joplin, Mo., has been appointed general manager of the Danbury & Bethel Gas & Electric Light Company, Danbury, Mo., succeeding the late Charles H. Merritt. L. W. Dickson, who has been Mr. Proctor's assistant at Joplin, is now in charge of that office.

J. C. ROCKWELL has been promoted from manager of the light and power department to general manager of the Manila (P. I.) Electric Railroad & Light Company. Mr. Rockwell was graduated in 1914 from Cornell University with the degree of mechanical engineer. Following his graduation he engaged in track construction work. In 1906 he became superintendent of transportation of the Syracuse (N. Y.) Lakeshore & Northern Railroad Company. He was appointed general superintendent in 1909 of the Charleston (W. Va.) Interburban Railroad Company, and the following year was elected general manager of the company. In 1911 he joined the operating organization of The J. G. White Management Corporation, New York City, and was assigned to the Manila Electric Railroad & Light Company as manager of the light and power department. Mr. Rockwell has been on a visit to the United States and is now returning to Manila.

Obituary.

HARVEY REYNOLDS, aged 52, office manager of the Muncie Electric Light Company, Muncie, Ind., died recently of pneumonia.

ELLIS B. BAKER, for many years general superintendent of the Southern New England Telephone Company, died at Petersburg, Fla., on April 16 at the age of 64. He was widely known and an efficient pioneer in the development of the telephone. The funeral was held in New Haven, the former home of the deceased.

CHARLES GORDON WADDINGTON, son of E. H. Waddington, Statesman-at-Large, Jovian Order, vice-president of the St. Louis Jovian League, met with death Tuesday, April 9, having been struck by an elevator at the offices of the Western Electric Company. He was in his eighteenth year, and was just entering his business career. In the short time he had been with the company he had made many warm friends, by his gentlemanly manner and congenial disposition. He was a member of the St. Louis Home Guards, and of the Triangle Club, an organization of the Baptist Church. At the funeral services held at the Second Baptist Church in St. Louis, April 10, a large number of St. Louis Jovians attended as did his entire company of the Home Guards. His body was interred in the family cemetery at New Castle, Pa.

Financial News

Annual Report of General Electric Company.

The financial exhibit of the General Electric Company for the fiscal period ended December 31, 1917, presents a record, sales have increased materially in every branch. The gross value of orders received was $246,778,491, compared with $169,585,058 in 1916 and $132,365,891 in 1915. For the first time in three years the company made no war munitions, the entire volume of orders in 1917 being for electrical and mechanical devices and machinery. In 1916 munition orders were $2,416,000 and in 1915 $33,980,000. After charging off $7,289,000 for federal taxes, the company shows net income equal to 26.50 per cent on common stock, as compared to 18.31 per cent in 1916, when there were no excess profits taxes and income tax was negligible.

The income account compares as follows:

	1917.	1916.
Net sales billed	$196,926,318	$134,242,290
Cost of sales billed, including all operating, maintenance and depreciation charges	167,921,778	118,948,199
Net profit	29,004,540	15,294,091
Sundry income	4,512,290	3,866,882
Net income	33,516,830	19,160,973
Interest	1,113,002	571,445
Balance	32,403,828	18,589,528
Excess profits tax, estimated	5,500,000	.....
Profit available for dividends	26,903,828	18,589,528
Dividends on stock.	11,165,882	8,121,646
Surplus for year	15,737,946	10,467,882
Previous surplus	34,160,753	23,692,871
Total surplus	49,898,699	34,160,753

The business of the General Electric Company in the current year is running slightly in advance of the corresponding period of 1917. Orders up to the week ended April 13, aggregated $69,589,000, as compared with $67,457,000 last year. This was at the annual rate of $240,000.000 for 1918, compared with $234,000,000 for 1917. The rate of orders received for this period of 1918 was 102 per cent of 1917, 140 per cent of 1916, and 302 of 1915.

A striking feature of the company's business is the notable increase in large orders received. Up to April 13 211 orders for amounts in excess of $25,000, were booked. The total amount of these orders was $28,529,000. For the same period of 1917, 196 orders over $25,000 were received for an aggregate sum of approximately $15,000,000. The 1916 record was 52 orders, totaling about $4,000,000. Government business is playing an important part in the company's prosperity, as a steady stream of orders is coming in for electric equipment needed in connection with war activities.

Allis-Chalmers' Statistical Exhibits for 1917.

Allis-Chalmers Manufacturing Company's statistical exhibits, published in March, showed unfilled orders on hand December 31, 1917, amounting to $27,087,250, which was greatly in excess of that previously recorded by the company.

Another feature of the report shows that the company expended during the year for maintenance, renewals, and general upkeep of plant and equipment $1,889,607, all of which has been charged to the cost of manufacture. In addition there has been set aside for depreciation, and charged to cost of manufacture, $941,907.

"To provide for the delivery of the largely increased volume of business it has been necessary to expend larger amounts than usual for capital improvements. These expenditures, aggregating $1,187,500, consist principally of additions to equipment and extensions of plant buildings.

"The net working capital of the company as of Dec. 31, 1917, comprising cash, receivables, marketable securities, and current inventories (less accounts payable), pay rolls, dividends and taxes accrued, and other current obligations, amounted to $16,431,545, as compared with $13,831,162 on Dec. 31, 1916, an increase of $2,600,383 for the year."

United Light & Railways' Net Gains.

Gross earnings of the United Light & Railways Company for the year ended December 31, 1917, increased $136,072 over those of 1916, according to the annual report of the company, while net, after taxes, increased, $135,707. The balance available for dividends on the common stock, depreciation, etc., increased $21,533. The income account, with comparisons, follows:

	1917.	1916.
Gross earnings	$2,054,893	$1,918,821
Net after taxes	1,907,620	1,771,913
Balance after interest	1,204,571	1,193,272
Dividends on first preferred	605,558	595,792
Balance available for common dividends, depreciation, etc.	599,043	597,480

Gross earnings of the subsidiary companies for 1917 were $7,705,268, as compared with $6,885,779 in 1916, and net earnings, after taxes and maintenance charges, were $2,658,361, against $2,666,393 in 1916.

Public Utility Stock Situation.

In discussing the stock situation, one of the leading financial papers states that public utility stocks have not stood up as well as other industrials since the beginning of the year. There appears to be a constant selling pressure in this part of the list. The reasons are obvious and no general governmental aid has yet appeared to help the utilities in their fight for higher rates. The total capital of public utilities in the United States exceeds $10,000,000,000 and the annual operating revenues exceed $1,500,000,000. Thos. N. McCarter, president of the Public Service Corporation of New Jersey, in a timely speech, pointed out that if widespread disaster was to be averted the public service commissions of the country must render aid. The rising costs of materials and labor cannot be combatted as long as rates for service are not raised. "The public must realize," said Mr. McCarter, "that in the public utility business, as in every other business, two and two make four, and it must be willing to pay a fair price for a thousand cubic feet of gas, a kilowatt hour of electricity, or a ride upon an electric car."

Copper Production, Imports, Exports and Profits.

A resumé of the copper situation at this time may be stated as follows: The production in the United States for the first quarter of 1918 amounts to around 550,000,000 pounds, which indicates that the supply for 1918 will adequately meet the demands at home and abroad. The imports of copper to this country are estimated at 69,000 tons for the first quarter of the year, far exceeding imports for that period in 1917. These imports, of course, are mostly from countries of North and South America.

The exports for the first quarter of the year are estimated at 92,000 tons, which is considerably less than the exports for the same period a year ago. The explanation is that England and France have an ample supply of copper at present, and this being the case, the available ships have been in service for the transportation of troops and food supplies. But it is logical to assume that copper shipments to our allies will be greatly increased as their demands for the metal becomes greater.

According to reports, an effort is to be made to get the Government to advance the price of copper 1 cent to 1½ cents per pound from existing price of 23½ cents to meet the increased costs of copper refining; but this action seems improbable in the face of the fact that an average net profit of 7 to 8 cents per pound is made by producers of coppers under the price of 23½ cents now in effect.

Weekly Bank Clearings Show Gain.

According to reports made to the Bradstreet Journal, bank clearings at the 50 largest cities of the United States for the week ending April 18 aggregated $6,130,089,000, which sum reflects a gain of 8.7 per cent over the previous week and of 5.8 per cent over the corresponding period for 1917. Outside of New York the total is $2,724,446,000, an increase of 7.1 per cent over the previous week and of 16.6 per cent over the same period last year. The loss at New York from last year is 1.3 per cent. Forty-one cities show larger totals than 1917, while nine exhibit losses. Chicago reports an increase of 3 per cent, Philadelphia five-tenths of 1 per cent, Kansas City, 46 per cent, Boston 40 per cent, St. Louis 16 per cent, San Francisco 7 per cent, Cleveland 12 per cent, Detroit 3 per cent, Baltimore 37 per cent, Cincinnati 36 per cent, and New Orleans 60 per cent.

Colorado Power Earns Three Times Bond Interest.

In the annual report presented by the Colorado Power Company for the year ended December 31, 1917, the consolidated net income of this public utility is placed at $357,665 after expenses and charges, an increase of $80,690 over 1916. The gross operating revenue was given at $1,183,750 and net revenue $676,301, compared with $1,020,310 gross and $562,781 net for 1916. Dividends paid on the preferred stock amounted to $44,718, while dividends on the common stock totaled $221,264.

In 1916, dividends on preferred and common stock amounted to $35,000 and $276,580, respectively. Profit and loss surplus, as of December 31, 1917, was $619,959, an increase of $91,161. The good showing made by the company in its annual report, at a time when public utility companies are showing recessions rather than gains over the previous year's figures, is due to the fact that the company generates 90 per cent of its energy from water power. Interest on bonds outstanding was earned more than three times, and there was set aside for depreciation $117,243.

"Continued increase of mining operation throughout the territory served," says President L. P. Hammond in his remarks to stockholders, "characterize the period. The estimated annual gross revenue from contracts signed during the year, less revenue from disconnected customers was about $240,000. On December 31, the company had under contract, not yet connected, retail power business estimated to produce additional gross operating revenue of $152,000.

"The continued substitution of retail for wholesale service has automatically increased the company's revenue per kilowatt-hour sold as a whole, this unit having increased from 0.941 cents in 1915, to 1.067 in 1916, and to 1.134 cents in 1917."

Dividends.

Cape Breton Electric Company, Ltd., has declared its regular semi-annual dividends of $3 on the preferred and $1.50 on the common stock, both payable May 1 to stock of record April 20.

Pacific Power & Light Company has declared a quarterly dividend of 1¾ per cent on preferred stock, payable May 1 to stock of record April 22.

Illinois Northern Utility Company has declared a quarterly dividend of 1 per cent, payable May 1 to stock of record April 20.

Bangor Railway & Electric Company has declared a quarterly dividend of ½ per cent, payable May 1 to stock of record April 20.

Pacific Gas & Electric Company has declared its regular quarterly dividend of $1.50 on the first preferred stock and $1.50 on the original preferred stocks, payable May 15 to stock of record April 30.

preferred and $3 on the common stock, payable May 15 to stock of record April 25.

Edison Electric Illuminating Company of Boston has declared a dividend of 3 per cent, payable May 1 to stock of record April 15.

Cities Service Company has declared the usual dividend of ½ of 1 per cent, monthly, on preferred stock, and ½ of 1 per cent in cash and ¾ of 1 per cent in stock on its common stock, all payable June 1 to stock of record May 15.

Shattuck-Arizona Copper Company has declared a dividend of 25c a share, payable July 20 to stockholders of record June 29. This is the same as the declaration made three months ago.

Texas Power & Light Company has declared a quarterly dividend of 1¾ per cent on preferred stock, payable May 1 to stock of record April 20.

American Waterworks & Electric Company has declared a quarterly dividend of 1¾ per cent, payable May 15 to stock of record May 10.

Idaho Power Company has declared a quarterly dividend of 1¾ per cent on preferred stock, payable May 1 to stock of record April 22.

Bellows Falls Power Company has declared a semi-annual dividend of 2½ per cent on preferred stock, payable May 15 to stock of record April 30.

Kellogg Switchboard Company has declared its regular quarterly dividend of 2 per cent, payable April 30 to stock of record of April 25.

Reports from London indicate that The Vickers Company has acquired control of the British Westinghouse, the control having passed to the Electric Holdings, Ltd.

Earnings.

NORTHERN ONTARIO LIGHT & POWER COMPANY.

Annual report of the Northern Ontario Light & Power Company for 1917, shows that the interest charge on the first mortgage 6 per cent sinking fund bonds was earned 2½ times. After payment of dividends on the preferred stock and depreciation charges of $50,000, there was a surplus of approximately $37,000, compared with a surplus last year of $44,981. Company has not paid dividends on the common since January, 1917. Delivery of power to the Kirkland gold mining district was made early in 1917, and earnings from this source contributed $67,768 to the gross. Other business, including power supplied to the Cobalt mines, shows substantial increases over 1916. Big demand for silver is a favorable factor in increasing company's business.

NEVADA-CAL ELECTRIC COMPANY. (and Subsidiaries.)

	1917.	1916.
November gross ..	$ 149,643	$ 140,380
Net after taxes	85,141	88,463
Surplus after charges	33,449	33,285
Eleven months' gross	1,825,934	1,393,263
Net after taxes ..	1,012,192	855,882
Surplus after charges	448,153	344,924

DETROIT EDISON COMPANY.

	1918.	1917.
March gross	$1,140,244	$1,044,105
Net after taxes.....	328,238	342,817
Surplus after charges.	231,144	257,871
Three months gross..	3,560,508	3,188,436
Net after taxes.....	1,066,971	1,154,311
Surplus after charges	775,472	899,369

SOUTHERN CALIFORNIA EDISON COMPANY.

Earnings of Southern California Edison Company for February and for the 12 months ending February 28, 1918, were as follows:

	1918.	1917.
February gross	$ 643,458	$ 667,294
Net after taxes	383,876	393,006
Surplus after charges	151,008	203,763
12 months' gross.....	8,168,531	8,409,356
Net after taxes.....	5,259,223	5,043,306
Surplus after charges	2,736,124	2,772,865
(Including all controlled companies.)		
12 months' gross.....	9,938,570	9,831,851
Net after taxes.....	5,894,368	5,600,031
Surplus after charges	3,013,664	2,949,442

DAYTON POWER & LIGHT COMPANY.

	1918.	1917.
March gross	$194,294	$149,775
Net after taxes	53,611	39,608
Surplus after charges and preferred dividends ...	6,377	1,322

WISCONSIN-MINNESOTA LIGHT & POWER COMPANY.

	1918.
Gross for twelve months.....	$1,730,863
Ending February 28, 1918.....	873,559
Surplus after charges.....	578,680

CITIES SERVICE COMPANY.

	12 months ending March 31, 1918.	12 Months ending March 31, 1917.	Month of March, 1918.	Month of March, 1917.
Gross earnings	19,850,979.25	13,391,411.41	1,975,211.82	1,721,480.77
Expenses	373,635.25	268,592.78	36,767.94	31,312.22
Net earnings	19,477,344.00	13,122,818.63	1,938,443.88	1,690,168.55
Interest on notes and debentures..	2,647.55	127,917.24	191.73	224.88
Net to stock	19,474,696.45	12,994,901.39	1,938,252.15	1,689,943.67
Dividends preferred stock	3,842,475.00	2,780,913.27	335,882.00	299,006.50
Net to common stock and reserves.	15,632,221.45	10,213,988.12	1,602,370.15	1,390,937.17
Contingent fund				881,634.98
Stock surplus				4,111,097.00
Surplus reserve				3,965,662.60
Surplus				18,602,572.48
Total surplus and reserves				27,560,967.06

AMERICAN TELEPHONE & TELEGRAPH COMPANY.

Earnings report for three months ending March 31, 1918:

	Average first quarter 1913-1915.	Average first quarter 1916 and 1917.	First quarter 1918.
Earnings:			
Dividends	$ 6,342,256	$ 6,784,599	$ 7,504,534
Interest and other revenue from associated companies	3,370,343	3,789,182	4,539,344
Telephone traffic (net)*	1,543,870	2,275,150	2,406,783
Other sources	201,778	543,318	287,347
Total	$11,458,247	$13,392,249	$14,738,008
Expenses	1,288,958	1,494,647	1,597,190
Net earnings	$10,169,289	$11,897,602	$13,140,818
Deduct interest	1,912,302	2,143,885	2,339,995
Balance	$ 8,256,987	$ 9,753,717	$10,800,823
Dividends paid	6,880,972	7,784,303	8,714,491
Balance	$ 1,376,015	$ 1,969,414	$ 2,086,332

*One month estimated.

WEEKLY COMPARISONS OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeiler & Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate. Per cent.	Bid Apr. 16.	Bid Apr. 23.
Adirondack Electric Power of Glens Falls, common.....	6	13	13
Adirondack Electric Power of Glens Falls, preferred.....	6	68	70
American Gas & Electric of New York, common.....10	+extra	..	86
American Gas & Electric of New York, preferred.....	6	39	38
American Light & Traction of New York, common.....	..	189	195
American Light & Traction of New York, preferred.....	6	93	94
American Power & Light of New York, common.....	4	40	40
American Power & Light of New York, preferred.....	6	70	70
American Public Utilities of Grand Rapids, common.....	..	20	..
American Public Utilities of Grand Rapids, preferred.....	6	50	..
American Telephone & Telegraph of New York.....	..	100	100
American Water Works & Elec. of New York, common.....	..	4¾	4¾
American Water Works & Elec. of New York, particip.....	7	13	13
American Water Works & Elec. of New York, first preferred...	..	57	57½
Appalachian Power of Bluefield, common.....	..	2¼	2¼
Appalachian Power of Bluefield, preferred.....	7	20	20
Cities Service of New York, common.....	+extra	202	201
Cities Service of New York, preferred.....	6	74½	74¼
Commonwealth Edison of Chicago.....	8	104	103
Comm. Power, Railway & Light of Jackson, common.....	..	22½	22
Comm. Power, Railway & Light of Jackson, preferred.....	6	47½	46½
Federal Light & Traction of New York, common.....	..	5½	5½
Federal Light & Traction of New York, preferred.....	..	26	28½
Illinois Northern Utilities of Dixon.....	6	..	..
Middle West Utilities of Chicago, common.....2	+extra	25	25
Middle West Utilities of Chicago, preferred.....	6	58	57
Northern States Power of Chicago, common.....ex. div.	7	40	40
Northern States Power of Chicago, preferred.....ex. div.	7	84	84
Pacific Gas & Electric of San Francisco, common.....	..	35	30½
Pacific Gas & Electric of San Francisco, preferred.....	6	..	..
Public Service of Northern Illinois, Chicago, common.....	7	75	74
Public Service of Northern Illinois, Chicago, preferred.....	6	84	82
Republic Railway & Light of Youngstown, common.....	4	22	22¼
Republic Railway & Light of Youngstown, preferred.....	6	56	56
Standard Gas & Electric of Chicago, common.....	..	4	4
Standard Gas & Electric of Chicago, preferred.....	6	24	23
Tennessee Railway, Light & Power of Chattanooga, common...	..	2¼	2¼
Tennessee Railway, Light & Power of Chattanooga, preferred...	6	8	8
United Light & Railways of Grand Rapids, common.....	4	28	27
United Light & Railways of Grand Rapids, preferred.....	6	58½	58
Western Power of San Francisco, common.....	..	13¼	13¼
Western Power of San Francisco, preferred.....	6	49	49
Western Union Telegraph of New York.....	extra	94⅞	93½
Industrials—			
Electric Storage of Philadelphia, common.....	4	48¼	48
General Electric of Schenectady	8	136¼	139½
National Carbon of Cleveland, preferred.....	8	*5€½	*56½
National Carbon of Cleveland, common.....	..	*130⅜	*130⅜
Westinghouse Electric & Mfg. of Pittsburgh, common.....+	extra	39⅛	40½
Westinghouse Electric & Mfg. of Pittsburgh, preferred.....	7	55	55

*Last sale.